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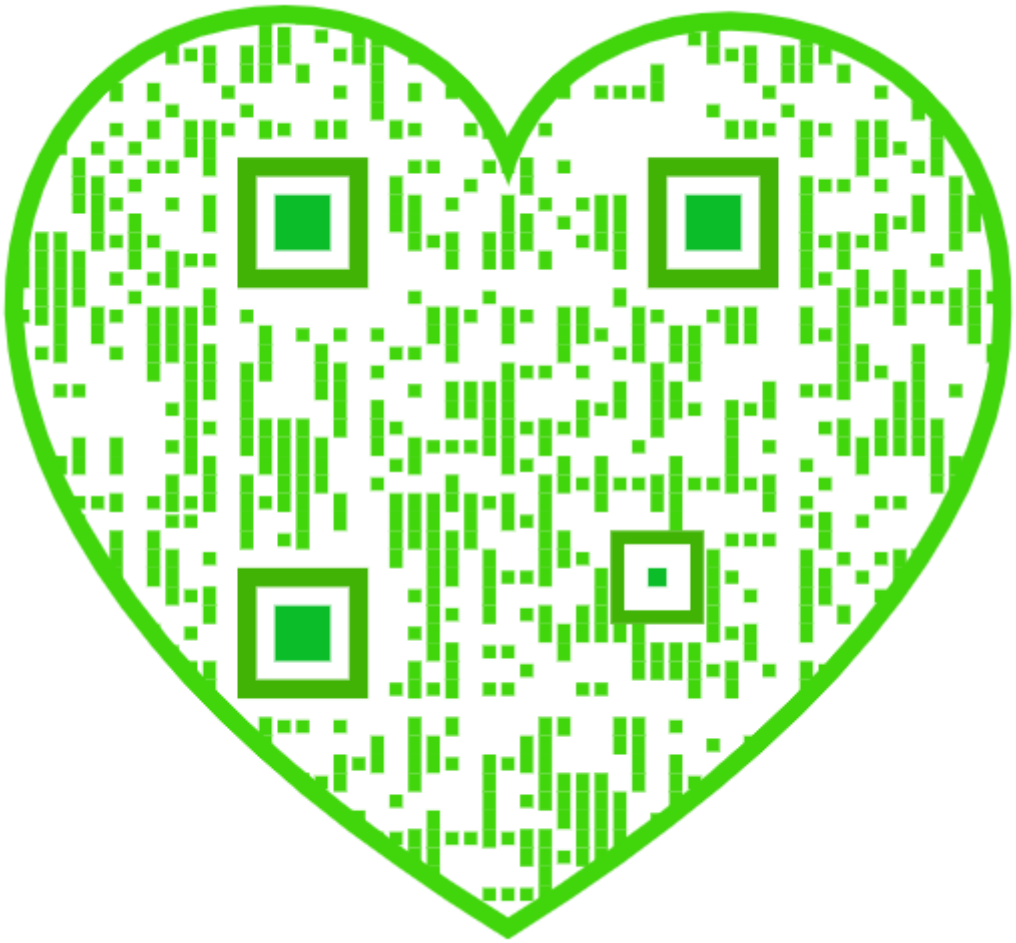
FEEDING DAIRY CATTLE

A series of articles
By PROF. E. S. SAVAGE,
as published in the
Holstein-Friesian World

THIRD EDITION
1921
Revised and Enlarged



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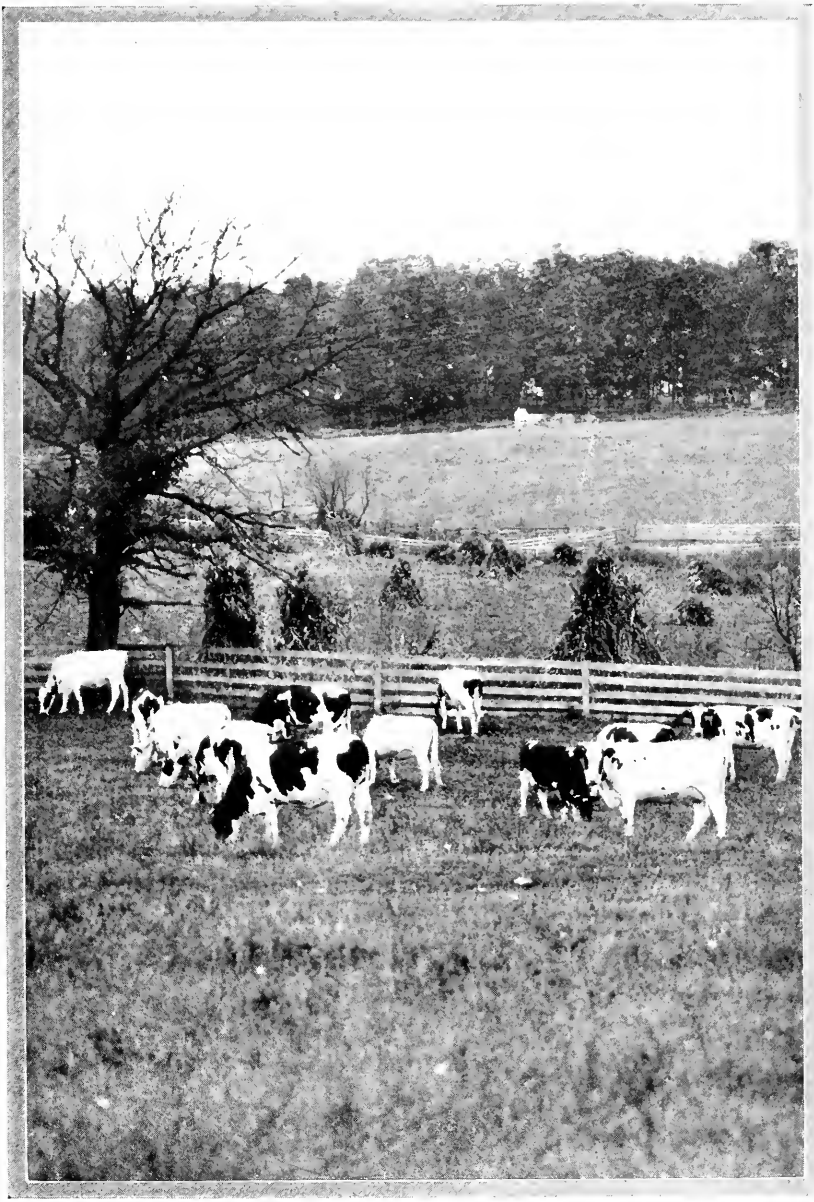
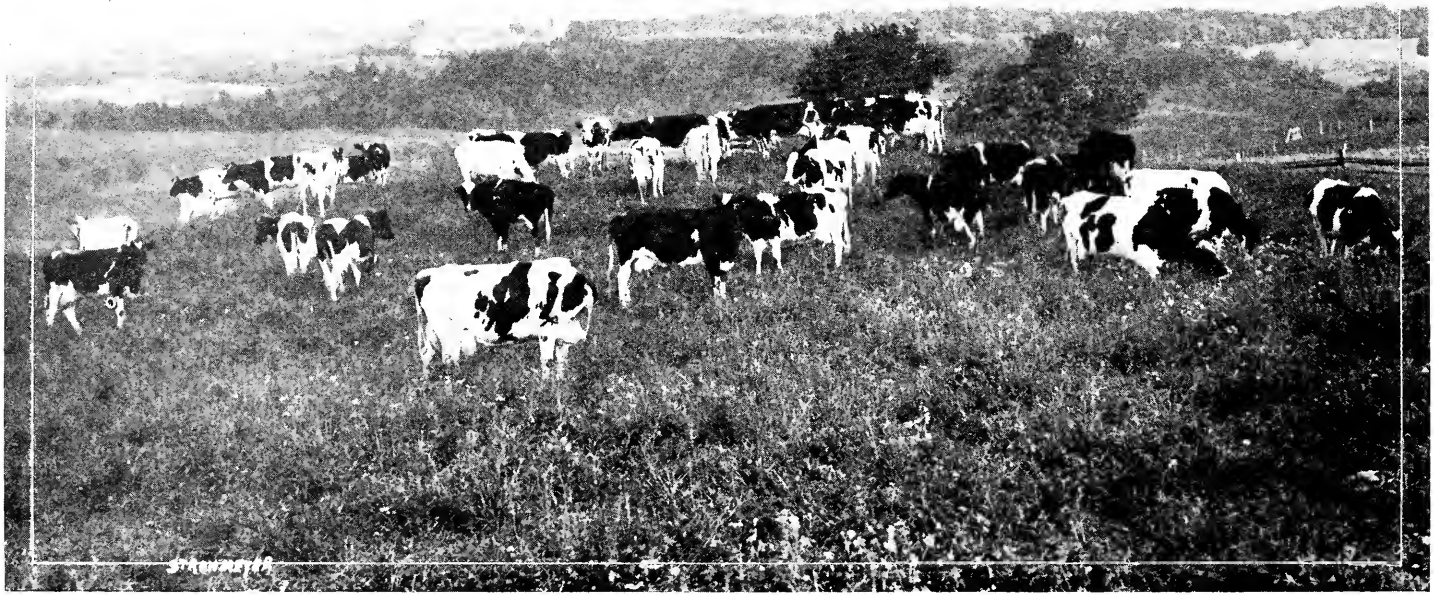


"The dairy farmer with purebred Holstein-Friesian cattle will keep up the fertility of his farm."



HOLSTEINS AT W. D. ROBENS' FARM IN NEW YORK
"One of the farmer's big questions is how to maintain fertility at least expense."

FEEDING DAIRY CATTLE

Third and Revised Edition 1921

By E. S. SAVAGE
Professor of Animal Husbandry
Cornell University

A series of articles published
in the
Holstein-Friesian World

SYRACUSE, NEW YORK

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Author's Note

IN the preparation of the following series the writer has endeavored to give in clear, concise language the application of science to practical feeding. In many cases the material has been written hurriedly without attempt at finished production, because the whole series has been written at odd times, as the duties of classroom and laboratory would allow. In every case it has been the intention to state no principle or practice that has not a firm place in the operations of our best dairy feeders.

In this time of stress the feeding of our animals is difficult. It is hoped that these articles may help feeders to get a firm basis on which to start their plans. The author hopes that after they are carefully read that they may be the stimulation which will cause the reader to study further the practice of other men and to correlate this practice with his own methods.

Ithaca, N. Y. E. S. SAVAGE.
October 1, 1921.

Introduction

THE Savage articles on Feeding Dairy Cattle have been published in the WORLD from 1916 to the present time. and were reprinted in book form in 1917 and again in 1918. Breeders and dairymen appreciated that nothing of this sort had ever before been prepared for their benefit—a series of practical articles giving explicit directions on the important question of how to feed their dairy cows most efficiently and most economically. In addition, it was written not only from the standpoint of the ordinary dairyman, but from the point of view of the Holstein breeder as well—the breeder who is anxious to make the most of his opportunities. In short, the book of Savage articles comprised the most complete, understandable and up-to-the-minute text-book of Holstein feeding information ever put together. The first edition was quickly snapped up by the breeders, and likewise by agricultural colleges and schools, who bought these books in quantity for text-book use. In view of this enthusiastic reception, backing up our judgment in the matter, we are issuing a third edition, revised and brought down to date.

The entire subject of feeding dairy cattle, as handled by Professor Savage, is based upon actual methods in use by successful dairymen. This book differs from the ordinary text-book in the important respect that every theory is made to deliver the goods in actual practice before it is accepted.

Professor Savage is recognized as an authority on feeding matters. His ideas have proven successful not only in his own experience, but in the hands of dairymen and breeders who have put them into practice. He is in charge of the foundation courses in Feeds and Feeding at Cornell University, and has done considerable experimental and research work in feeding in that institution. Several cows with records of 30 to 35 pounds have been bred and developed in the university herd, and one of these cows, Glista Ernestine, has made seven different 30-pound records. The handling of these cows forms the basis of an interesting chapter in this book. The details of the care and feed of a number of the leading producers, in both short and long-time tests, as given by the men in actual charge, form the basis of other chapters, invaluable to the man who is interested in getting the greatest possible returns from his test work.

Altogether we can commend this book to our Holstein friends in full confidence that its careful study will result in added knowledge of the subject of feeding that will be of practical service to them in their business as Holstein breeders and dairymen.

THE WORLD.
Syracuse, N. Y.,
October 1, 1921.

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Introductory

Dairying and Permanent Agriculture

TO ESTABLISH the basis upon which this paper is founded we cannot do better than to quote from "The Holy Earth," by L. H. Bailey, what is said beginning the chapter, "The Farmer's Relation":

"The surface of the earth is particularly within the care of the farmer. He keeps it for his own sustenance and gain, but his gain is also the gain of all the rest of us. At the best he accumulates little to himself. The successful farmer is the one who produces more than he needs for his support; and the over-plus he does not keep; and, moreover, his own needs are easily satisfied. It is of the utmost consequence that the man next to the earth shall lead a fair and simple life, for in riotous living he might halt many good supplies that now go to his fellows.

"It is a public duty so to train the farmer that he shall appreciate his guardianship. He is engaged in a quasi-public business. He really does not even own his land. He does not take his land with him, but only the personal development that he gains from it. He cannot annihilate his lands, as another miht destroy all his belongings. He is the agent or the representative of society to guard and subdue the surface of the earth, and he is the agent of the divinity that made it. He must exercise his dominion with due regard to all these obligations. He is trustee. The productiveness of the earth must in crease from generation to generation; this also is his obligation."

That last statement is the fundamental: "The productiveness of the earth must increase from generation to generation; this also is his obligation." This obligation works no hardship on the dairy farmer; on the contrary the more closely he carries it out, the more money he himself will make, and so much the better his farm will be when he leaves it than when he takes it in the beginning.

All this is simply saying that every farmer must return to the soil each year, a little more fertility than he takes from it. In no other way is he truly farming; he is simply mining and on most of our farms too much mining has already been done. We must now begin to farm.

The dairy farmer with pure-bred Holstein-Friesian cattle, who is aiming at a high production with that herd, will, without any doubt, keep up the fertility of his farm; and, for that matter, add to its fertility. Let us take the case of a farmer who has 20 cows, the average production of which he aims to make 10,000 pounds per year. This is a good high aim, but not impossible of achievement, and no one should be satisfied with less. What must this farmer do to make money for himself and at the same time turn over his land to posterity better than he found it? He must do three things: (1) He must grow legumes and corn silage for roughage; (2) he must be careful in the purchase of concentrates; (3) if he sells money crops, he must aim to purchase enough commercial fertilizer to replace the material sold in the cash crops. We will suppose that this farmer sells from his farm each year the following: Five cows, weighing 1,000 pounds each; 15 tons of timothy hay, 1,000 bushels of potatoes, and 200,000 pounds of milk. The fertility sold from the farm would be:

	Nitrogen, pounds	Phosphoric acid, pounds	Potash pounds
Five 1,000-pound cows.....	116.5	77.5	9.0
15 tons timothy hay.....	297.0	93.0	408.0
1,000 bushels potatoes.....	210.0	72.0	318.0
200,000 pounds milk.....1120.0		380.0	340.0

Therefore this farmer must balance these amounts with the same amount of fertilizing constituents brought onto the farm in one form or another. He can do it by the purchase direct of commercial fertilizers, but is it necessary for him to do this? No; only in part. If he is judicious in the selection of feeds, he can make up a large part of this loss through those that he purchases.

To produce 10,000 pounds of milk in one year, it will be necessary for him to feed each cow at least 12 pounds of a good mixture of grains 250 days in the year. At this rate for the 20 cows, 32 tons at least will be necessary. A good mixture at present prices is 500 pounds distillers' dried grains, 500 pounds hominy feed, 500 pounds wheat bran, 300 pounds gluten feed, 200 pounds linseed oil meal.

This is an example of the kind of mixture that should be fed to bring the most fertility to the farm and be of high feeding value also. How much fertility will 60,000 pounds of this mixture add to the soil after it has passed through the dairy cow?

First, we must see what becomes of the nitrogen, phosphoric acid and potash in the feed when it is fed to a dairy cow. She is normally neither gaining nor losing live weight,

therefore, she is not storing anything in her body except what may go to the foetus, and that is a comparatively small amount during more than one-half the year. There are only three channels through which the fertilizing elements in the feed may disappear, the milk, the manure, and the urine. Seventy-five and five-tenths per cent. of the nitrogen appears in the manure and urine, and the balance, 24.5 per cent., appears in the milk. Eighty-nine and seven-tenths per cent. of the phosphoric acid and potash appears in the manure and urine, and the balance, 10.3 per cent.. appears in the milk. Therefore, we see that a large part of the fertility purchased in feeds is available to the land. This has never been studied as carefully as it should be in this country, because up to the present, little thought has been needed to be given on account of the virgin condition of our soils and the immense stores of fertility in them. Of course, these stores are no way exhausted, but must be conserved. In older countries like England, farmers have had to be careful of the fertility in their soils, and we will turn for a moment to the English law regarding this point.

This law is quoted from "Feeds and Feeding", by Henry & Morrison:

"British practice—in Great Britain, where many of the farmers are long period tenants, the manurial value of feeding stuffs is recognized by law in a manner that tends greatly to the betterment and permanence of her agriculture. The Agricultural Holdings Act, which is the law governing the relations between landlord and tenant, direct that when a tenant is vacating his leasehold he shall be reasonably compensated for the improvements he has made. Among these, credit must be given for the fertilizing value of feeding stuffs which the tenant may have purchased and fed out, and also, under certain conditions for the fertilizing value of grains produced on the farm and fed to stock. In order to furnish data to guide the valuers who serve in settlement between landlord and tenant, after full and extended study, Lawes & Gilbert and later Voelker & Hall, of the Rothamstead Experiment Station, drew up tables showing the compensation to be allowed for the fertilizing value of various feeds. The recommendations, as revised in 1913 and adopted by the Central Association of Agriculture and Tenant Right Valuers, are that the tenant shall be credited as follows for all manure resulting from feeding purchased feeds to stock on the leasehold.

"For all unused manure, or that which has been recently applied to the land, without a crop being grown thereafter, a credit of three-fourths of the total value of the phosphoric acid and potash in the feed is allowed. Because a greater loss of nitrogen commonly occurs in stored manure than in manure dropped in the field by animals at pasture, a credit of 70 per cent. of the total value of the nitrogen is allowed when the stock have been fed at pasture and of only 50 per cent. when they have been fed in the barn or yard."

We all know that in all countries the material written into the law is conservative. Therefore, the following amounts of fertilizing materials estimated from the materials in the feeds in the 60,000 pounds of the mixture above suggested, are conservative estimates. The total available nitrogen, if the feed had been spread on the ground, has been multiplied by one-half, as allowed in the above extract from the English law, and the available phosphoric acid and potash by three-fourths. The 60,000 pounds of the mixture has been separated into its different constituents in order that the difference in feeds might be seen.

	Available in Manure		
	Nitrogen, pounds	Phosphoric acid pounds	Potash, pounds
15,000 lbs. Distillers' dried grains	368.2	76.5	19.2
15,000 lbs. Hominy feed	127.5	139.5	106.8
15,000 lbs. Wheat Bran	192.0	331.8	182.4
9,000 lbs. Gluten feed	182.7	41.7	15.6
6,000 lbs. Oil meal	162.6	76.5	57.3
Totals	1033.0	666.0	381.3

It will be seen that the above goes a long way towards offsetting the fertility that has been sold off the farm. It almost completely offsets the fertility that is sold in the milk, leaving only that sold in the money crops to be replaced by the farmer.

This brings sharply to light the first fact that we wish to establish, that by the judicious selection of feeds, all the fertility that is sold as market milk may be fully replaced by the fertility in the feeds, even when the fertility in the feeds is conservatively estimated.

In the above tables, comparing milk with the feeds, there is a slight shortage in the nitrogen. We must remember, however, that only 50 per cent. of the available nitrogen in the feed has been computed. Then, if legume crops are grown, whatever of nitrogen is taken from the air is clear gain. This emphasizes the importance of the growing of legumes.

Nothing has been said about the money value of these

fertilizing constituents. The writer leaves that for the interpretation of the reader. Nitrogen on the average for the past 10 years has been worth 18 cents per pound, phosphoric acid 4.5 cents and potash 5 cents. All are more expensive at present. Therefore, we see again the importance of getting what we can in feeds. As to choice of feed, without going into detail, the high protein feeds—cottonseed meal, gluten feed, etc.—yield the nitrogen, and the feeds like wheat bran made up of the outer coatings of the kernel, carry the most potash and phosphoric acid.

Upon looking at this first table, we can see that mature animals carry away relatively the least fertilizing elements, therefore, the Holstein breeder, who is feeding his milk and selling mature animals at high prices, is conserving the fertility of his farm. Therefore, the greatest gain to be made in dairy farming, from the standpoint of a permanent agriculturist, is to aim for the best blood there is and to make the surplus stock the main cash crop of the farm.

Then again, if milk must be sold, a glance at the first table will show that if the milk can be sold to a factory, so the skim milk can come back to the farm, or if butter can be made on the farm, a great saving of fertility is made.

Therefore, as far as possible, from the standpoint of a permanent agriculturist, the dairy farmers must learn to grow legumes and to market their crops in cream and butter and mature animals at high prices.

Part One—Feeding Dairy Cattle

1. The Composition and Selection of Concentrates

THE question of feeding dairy cattle is largely a question of growing roughage suitable for the cows on the farm; in some cases the growing of a little grain, and lastly and most important of all, the selection of the proper purchased feeds to supplement the ones grown at home.

A feed is grown or purchased for the total digestible material in it. The water and the indigestible matter are of no particular use to the animal and are like the "filler" in a fertilizer. Therefore the study of the selection of feeds either to be grown or to be purchased must be based on the cost of the digestible material and the needs of the cow for certain particular things in her ration. The things needed in a ration are digestible protein, digestible carbohydrates and digestible fat. These are familiar terms to all readers and need no particular discussion here. When a feed is purchased or grown it is for the digestible protein, the digestible carbohydrates and the digestible fat in it. The feeds to be chosen are those in which we can get the most of these things for one dollar.

The ordinary coarse feeds grown on farms are mixed hay, corn silage and cornstalks or fodder. The grains ordinarily grown are corn, oats, barley and buckwheat. We must purchase feeds to properly supplement these feeds we grow at home and study the growing of those that will give us the most at the least cost. For purposes of convenience it is customary to add together the digestible protein, digestible carbohydrates and digestible fat multiplied by 2¼ and call the result the total digestible nutrients. This is usually computed on the ton basis. For example: there are in 100 pounds of gluten feed, 21.6 pounds of digestible protein, 51.9 pounds of digestible carbohydrates and 3.2 pounds of digestible fat. $3.2 \times 2\frac{1}{4} = 7.2$ plus 51.9 plus 21.6 equal 80.7 pounds of total digestible nutrients in 100 pounds of gluten feed. The fat in any feed is worth 2¼ times as much as the carbohydrates and protein, therefore the fat is multiplied by 2¼ before adding. 80.7×20 equal 1614

pounds of total digestible nutrients in one ton (2000 pounds) of gluten feed. Therefore when we buy a ton of gluten feed for $33.50, as quoted below, we pay the $33.50 for the 1614 pounds of digestible material in the ton. One hundred pounds of total digestible material in gluten feed would cost $2.08. In this way the cost of digestible material in all feeds may be calculated and the results used as a basis in the selection of the crops that shall be grown for roughage and in the selection of the supplements that must be purchased. Such a table is worked out below as the basis for the selection of the proper feeds to purchase at the present time to go into a ration.

In all rations for dairy cattle there must be sufficient protein. In the ordinary roughages grown on the farm and in the grains grown on the farm there has been a lack of protein, so the second thing to be considered in the purchase of feeds is the amount of protein in each. To make this a matter of easy consideration the feeds listed below are divided into high protein, medium protein and low protein groups. How to make use of this grouping will be explained later.

As for roughage all that need be said is that on the basis of the cost of digestible nutrients alone the roughage that all dairymen must grow is corn silage. In no other crop can so much be obtained for one dollar as in corn silage. Next in importance is the growing of legume hays. The possession of a sufficient quantity of good corn silage and of good clover or alfalfa hay gives us the finest kind of a start in the selection of the feeds that shall make up the ration. No farmer can afford to be without these roughages.

Now to make this lesson definite we will proceed to the selection of the concentrates which we would choose to make a mixture to supplement good clover hay and corn silage in a ration. Below as a starting point is given a table of the feeds commonly listed by feed dealers, arranged according to high, medium and low protein content.

The figures in the last column are obtained by dividing the cost per ton by the total digestible nutrients in one ton of each feed and multiplying the result by 100. It is this column and the amount of protein in each feed which guide us in the proper selection of the feeds. This is the proper starting place. This knowledge must be supplemented by a thorough knowledge of the peculiar usefulness of each feed in milk production.

COMPOSITION OF CONCENTRATES

	Per cent. digestible protein	Total digestible nutrients in one ton	Cost per ton	Cost of 100 lbs. total dig. nut.
(High Protein)				
1. Cottonseed meal	37.0	1564	$37.50	$2.40
2. Linseed oil meal	30.2	1558	37.00	2.37
3. Distillers' dried grains	22.4	1778	32.75	1.84
4. Gluten feed	21.6	1614	33.50	2.08
5. Brewers' dried grains	21.5	1314	28.50	2.17
6. Malt sprouts	20.3	1412	28.50	2.02
(Medium Protein)				
7. Flour middlings	15.7	1564	30.00	1.92
8. Wheat mixed feed	12.9	1340	26.75	2.00
9. Wheat bran	12.5	1218	24.50	2.01
(Low Protein)				
10. Ground oats	9.4	1400	35.10	2.51
11 Ground barley	9.0	1588	35.00	2.20
12. Hominy	7.0	1692	30.00	1.77
13. Corn meal	6.9	1676	30.90	1.84
14. Dried beet pulp	4.6	1432	26.50	1.85

To insure the proper amount of protein in the ration, about one-half of the feed should be chosen from among those containing a high amount of protein. The following mixture is suggested, taking all of these things into account:

500 lbs. hominy	$7.50
500 lbs. distillers' dried grains	8.19
500 lbs. mixed feed	6.69
300 lbs. gluten feed	5.03
200 lbs. oil meal	3.70
2000 lbs. (one ton)	$31.11

It is seen that 1000 pounds of this mixture is made up of distillers' grains, gluten feed and oil meal. The oil meal was not chosen as yielding total nutrients very cheaply, but because the writer wishes particularly to have a little oil meal in his ration. All the others in the suggested mixtures will be found to yield total digestible nutrients the cheapest.

The author has found this method of great assistance in studying the relative value of feeds and in forming a basis for the choice of feeds. In using this method current prices of feeds should be substituted for those given and the table calculated over. Your farm bureau agent usually has the prices.

The above mixture is advised with practically any roughage. It would go particularly well with clover hay and corn silage. If no silage is available it will be noticed in the table that dried beet pulp and malt sprouts are relatively cheap feeds. They make excellent succulent feeds if soaked eight or ten hours before feeding. Not as much other grain would be needed with these soaked grains.

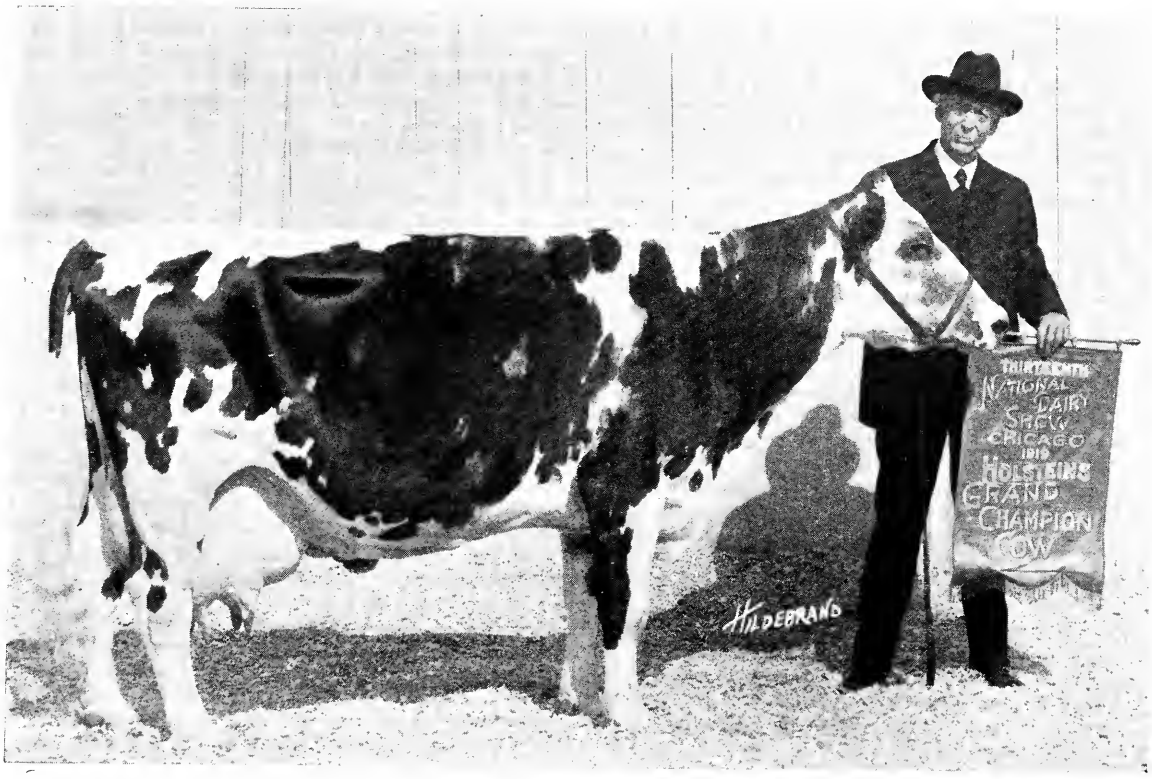
II. The Manurial Value of Feeds

ALL true farmers believe in a system of farming which is a little better than permanent agriculture. A system of permanent agriculture means one in which as much fertility is added to the soil each year as is taken off in the farm crops, thus the farm is permanent. Every good farmer believes in having his fields a little richer and better each year than they were the year before, and that means that he must have added a little more fertility than he has taken away. If he does this he is carrying on a system which is more than permanent. Consequently, one of the big questions is how to maintain fertility at the least expense. Some help on this question is the aim of this paper.

The cost of nitrogen per pound from year to year has averaged about 18 cents, of phosphoric acid 4.5 cents and of potash 5 cents. Due to the war, current prices are somewhat higher than these but are coming down gradually. Therefore anything at this time that will help keep up the fertility of the farm will be of great service. One source that must not be overlooked is the fertilizing constituents in feeds. Here is where the dairy farmer has an advantage over his neighbors, hay and grain farmers, because he has a lot of manure to use, and is a big purchaser of feeds. From a manurial standpoint how can he get the most for his dollar in maintaining and building up the fertility of his farm? There are two main things that he must know, and concerning them he must put his knowledge into practice. First, he must know in which feeds he will get the most fertility. Secondly, he must so care for the manure and urine that none of the fertility will be lost. We will endeavor to show first how much fertility there is in the common feeding stuffs and show how he may quickly compare feeds on this basis.

No one questions the importance of growing all the legume roughage that it is possible to grow. In this we have a happy combination of circumstances. On practically every dairy farm in the whole country it is possible to grow either clover or alfalfa. These hays make the foundation of the ration and are ideal roughages. In growing them the farmer gets one fertilizer constituent, nitrogen, to some extent free from an inexhaustible source, the air. The amount of nitrogen gathered in this way by large crops of legumes amounts to a great deal, and adds directly to the permanent

WISCONSIN'S BLUE RIBBON GROUP IN THE STATE HERD CONTEST AT THE 1921 NATIONAL DAIRY SHOW



MINERVA BEETS

Grand Champion National Dairy Show, 1914-16-17-18-19. This photograph was taken after her fifth championship in 1919, when she had attained the age of almost fourteen years.

value of the land at practically no cost to the farmer. In addition to roughage he may grow some grain, but rarely does a farmer grow enough to feed his own cows. Therefore he must be familiar with the fertilizing constituents of the feeds that he must purchase to supplement those that he raises.

When feed is fed to an animal only that portion is available as a fertilizer which passes out from the animal in the manure and urine. The percentage of each fertilizing constituent which will appear in the manure varies with the animal. With a mature horse, neither gaining nor losing live weight, all the nitrogen, phosphoric acid and potash in the feed must appear in the manure and urine, otherwise the horse would of necessity gain in weight.

The percentages of nitrogen, phosphoric acid and potash recovered in the manure and urine from different animals as given by Henry and Morrison are as follows:

PROPORTION OF NITROGEN, PHOSPHORIC ACID AND POTASH OF FEED WHICH IS VOIDED BY ANIMAL

	Nitrogen, per cent.	Phosphoric acid and potash per cent.
Horse at work	100.0	100.0
Fattening ox	96.1	97.7
Fattening sheep	95.7	96.2
Fattening pig	85.3	96.0
Milch cow	75.5	89.7
Calf, fed milk	30.7	45.7

These percentages are higher than the amounts recovered in common practice. For calculation in the choice of feeds for a ration it has been deemed best to adopt the plan given in English law which governs the relations between landlord and tenant. The following principles of English law as recommended and adopted by the Central Association of Agriculture and Tenant Right Valuers are quoted from Henry and Morrison:

"For all unused manure or that which has been recently applied to the land without a crop being grown thereafter, a credit of three-fourths of the total value of the phosphoric acid and potash in the feed is allowed. Because a greater loss of nitrogen commonly occurs in stored manure than in manure dropped in the fields by animals at pasture, a credit of 70 per cent. of the total value of the nitrogen is allowed when the stock have been fed at pasture and only 50 per cent. when they have been fed in barn or yard.

"When one crop has been grown since the application of the manure, a part of the fertility thereby being used up, the credit allowed is only half that stated above. It is

realized that the beneficial effects of farm manure persist much longer than two years, but owing to the difficulties of checking records for a longer period, the compensation is not extended over a greater time. The principle of the English law, as set forth, should be drafted into every lease drawn between landlord and tenant in this country."

In accordance with these principles the following table has been computed:

MANURIAL VALUES PER TON

Feed	Cost per ton	Manurial value per ton	Net cost per ton
Corn meal	$31.00	$3.37	$27.63
Hominy feed	30.00	4.62	25.38
Gluten feed	31.00	7.91	23.09
Flour wheat middlings	30.00	5.13	24.87
Wheat bran	**24.00**	**7.81**	**16.19**
Wheat mixed feed	25.00	6.08	18.92
Ground oats	33.00	4.53	28.47
Ground barley	35.00	4.42	30.58
Malt sprouts	28.00	10.10	17.90
Brewers' grains, dried	29.00	8.37	20.63
Cottonseed meal, choice	38.00	15.87	22.13
Linseed oil meal, old process	35.00	11.87	23.13
Beet pulp, dried	28.00	3.01	24.99
Distillers' grains, dried	31.00	9.43	21.57

The manurial values here given are those computed on the basis that a dairy cow returns in the urine and manure 50 per cent. of the nitrogen and 75 per cent. of the phosphoric acid and potash in the feed as fed. The value has been circulated by multiplying the pounds of nitrogen by 18 cents, the phosphoric acid by 4.5 cents and the potash by 5 cents.

Objection may be made that no such values are ever recovered in ordinary practice. Fippin in the Cornell Reading Course for the Farm, Lesson 127, uses percentages less than these. Whatever percentages are used the principle is the same and the amounts recovered are large and important. Attention is therefore called again to the first table, which says on good authority that 75.5 per cent. of the nitrogen and 89.7 per cent. of the phosphoric acid and potash are returned by a dairy cow, and then consider that the percentages, 50 for nitrogen and 75 for phosphoric acid and potash, are used from the law. All men know how conservative are the figures written into law. Again, we have used low prices as compared with the present prices for nitrogen, phosphoric acid and potash.

Concerning the care of the manure and urine, again it must be emphasized that more than half of the manurial value of each feed is in the nitrogen. Practically all of the nitrogen of the feed is returned in the urine. Therefore all the urine must be absorbed and the manure so kept that no

fermentation or heating can take place. The best method is to spread it over the fields every day. In case this is not possible it is at least possible to prevent leaching of the pile. Heating is hard to control, but tramping it down hard will help. If the manure can be stored in a place where it can be tramped hard by animals very little heating will take place. This might be accomplished with young stock or hogs.

III. By-Products Used in Feeding Dairy Cattle

DAIRY farmers will be troubled to procure feed for their cows during the next six months if the indications at present are of any value. On account of the war and the great demand for cereals for human food, good prices are bound to be high even with a great crop this year. Therefore this article has been planned to give some additional information concerning the by-products that may be used in feeding dairy cows. This article may be dry reading but it is hoped that there is valuable information in it for the dairyman who will take the time to read it through.

All the concentrates that may be used for dairy cattle may be put into three groups for convenience in arranging proper mixtures. These groups are a high protein group, medium protein group and a low protein group. The high protein group contains those feeds with a nutritive ratio of 1 : 3 or narrower, the medium protein group those feeds between 1 : 3 and 1 : 6, and the low protein group those feeds with a nutritive ratio of 1 : 6 or wider.

In general it may be said that a mixture of feeds in which at least one-half by weight are high protein feeds will be a good mixture to feed. One-third of the mixture by weight should be made up of bulky feeds. The high protein feeds have in general the highest manurial value and so on down to the low protein feeds which have the lowest manurial value. This is due to the fact that nitrogen is the most valuable fertilizing constituent in feed and all the nitrogen in a feed is found in the protein. Therefore the high protein feeds leaving the most nitrogen would have the greatest manurial value.

Many, many farmers choose feeds according to the protein content of the feed almost entirely. This is a very important thing to consider but is incorrect if it is the sole factor considered. Feeds have a value in direct proportion to the total digestible matter in them in all rations with

sufficient digestible protein. Only when the ration as a whole, considering both roughage and concentrates, is lacking in protein does a high protein feed have a value above the value of a low protein feed, having the same digestible nutrients per ton, except that the high protein feed always has the greatest manurial value.

CORN AND ITS BY-PRODUCTS: With the above introduction we may now consider somewhat in detail the by-products that may be used. The manufacturing process using corn as raw material give us as foods for dairy cows, distillers' dried grains, gluten meal and gluten feed in the high protein class; germ oil meal in the medium class; corn bran and hominy feed in the low protein class. Corn meal and corn and cob meal comes in this latter class although not by-products.

Distillers' grains, from the manufacture of alcohol and whiskey, are one of the finest feeds for their high protein content and the large amount of total digestible material. They are also bulky. They may well form the foundation of a ration.

Gluten meal differs from gluten feed in that corn bran is not added in the case of the meal. This makes the meal less bulky and with a high protein content. Gluten feed has the corn bran in it. Corn bran is like wheat bran and is somewhat more valuable. Corn bran, gluten meal and gluten feed all arise in the manufacture of starch and glucose from corn. There is not much gluten meal on the market. Gluten feed may be used as a high protein feed and naturally is classed with cottonseed meal where bulk is not needed. Distillers' grains would be chosen if bulk is needed in the mixture.

Hominy feed comes from the manufacture of corn foods for human consumption. It is somewhat more valuable than corn meal for dairy cows and will keep better in bulk. These corn by-products are all very useful in feeding. Germ oil meal also arises in the process of starch and glucose manufacture. It is the cake remaining after oil is expressed from the germs or pits of the corn kernel.

WHEAT AND ITS BY-PRODUCTS: Wheat gives us several medium protein by-products. Ground wheat itself falls into the low protein class. Wheat bran, standard wheat middlings, flour wheat middlings, and red dog flour are all separated mechanically in the process of flour making from wheat. They increase in total digestible matter and decrease in bulkiness in the order named. The finer products

are not so good in dairy rations as wheat bran. However, all may be used if the total bulk of the mixture is properly maintained through the use of other feeds. The relative value may be computed by means of the amount of total digestible nutrients. Reference to the table in this article will show this. Wheat mixed feed is the mixture of the mill run of all these separated wheat by-products. That is, if the wheat bran, standard wheat middlings, flour wheat middlings and red dog flour from one hundred bushels of wheat milled into flour were all mixed together, the result would be wheat mixed feed from such milling. Good mixed feed is more valuable than wheat bran.

RYE BY-PRODUCTS: Rye mixed feed is practically the only by-product from rye. It is a medium protein feed of practically the same value as wheat mixed feed but is not so palatable.

BARLEY BY-PRODUCTS: Ground barley is in the low protein class and is as valuable as corn or hominy feed. When manufactured into beer we get two by-products, malt sprouts and brewers' dried grains. Both these feeds are bulky and high in protein. They are both more valuable than wheat bran but are not so valuable as such high protein grains as distillers' dried grains and gluten feed. There seems to be a prejudice against malt sprouts and brewers' dried grains but if fed by weight it will be found that they are valuable. They are so bulky that one is deceived and apt to underestimate their value when fed by measure. Malt sprouts wet up are valuable as a source of succulence when one has no silage. In the opinion of the writer these feeds when properly mixed with others, have a value commensurate with their content of total digestible nutrients.

OAT BY-PRODUCTS: In the milling of oats the by-products analogous to those from the milling of wheat arise. They are not generally marketed as such, but for the most part find their way into ready mixed feeds. Care should be taken in the purchase of ground oats to see that not too many hulls are present. Ground oats are often made from light oats. The writer has seen a difference of four per cent. in the crude fiber content of two cars of ground oats bought at the same price at the same time from two well rated companies.

COTTONSEED MEAL, LINSEED OIL MEAL AND MISCELLANEOUS BY-PRODUCTS: Cottonseed meal arises in the production of cottonseed oil from cottonseed. It is a very valuable by-product of the high protein group. It is much like gluten

feed. Either of these may be safely fed to the extent of four pounds per day per cow. In a ration in which both cottonseed meal and gluten feed are found, not more than four pounds of both should be fed. Much has been said about the trouble that these two feeds cause, but from the fact that so much of both are fed in the best dairies, it seems to the writer that fears are groundless in feeding them in moderation.

Linseed oil meal is a by-product from flax in the manufacture of linseed oil. This feed has a great value because of its laxative effect as well as its value as a feed in itself.

Cocoanut oil meal and peanut oil meal sometimes are on the market. They are much the same in effect as the other oil meals and are valuable in proportion to their digestible nutrients.

Dried beet pulp is very valuable, particularly when succulent feed is needed. It wets up readily and is very palatable.

Many other feeds might be mentioned. A farmer might well study the possibility of buying a car of grain screenings or of salvage grain and make that the basis of his feeding operations. Screenings are as valuable as wheat bran when of good quality and the value of salvage grain would depend on the kind and the amount of damage. Screenings from wheat are separated from the wheat before it is milled and when of good quality consist mainly of weed seeds and broken grains of wheat. Screenings should always be ground. The ground screenings are now run into wheat bran and wheat middlings in many mills. Salvage grain is grain damaged by fire or water and afterwards kiln dried. As a rule it is well liked by animals.

PRECAUTIONS: In the purchase of concentrates of all kinds the tag should always be examined to know whether the analysis is up to the standard or average of that particular feed or not. The experiment station of nearly every state publishes a bulletin on the analysis of the feeds used in that state. Every reader of THE WORLD should provide himself with these tables of analysis and buy on analysis and on the content of total digestible nutrients. Agricultural newspapers, experiment stations, farm bureaus all are ready and willing to give information along these lines. Much money can be saved and made by the intelligent buying of feeds.

A brief table is appended showing the grouping of feeds

and their relative values on the basis of total digestible nutrients in one ton of each:

GROUPS OF FEEDS	Total digestible nutrients in one ton
High Protein	
Distillers' dried grains	1778
Gluten meal	1680
Gluten feed	1614
Brewers' dried grains	1314
Malt sprouts	1412
Buckwheat middlings	1532
Prime cottonseed meal	1510
Linseed oil meal	1558
Medium Protein	
Germ oil meal	1650
Wheat bran	1218
Standard wheat middlings	1386
Flour wheat middlings	1564
Red dog flour	1584
Wheat mixed feed	1340
Rye mixed feed	1490
Low Protein	
Corn and cob meal	1562
Corn meal	1676
Hominy feed	1692
Corn bran	1462
Ground wheat	1602
Ground rye	1620
Ground barley	1588
Ground oats	1408
Ground buckwheat	1268
Dried beet pulp	1432
Molasses	1184
Wheat screenings	1340

IV. The Selection and Value of Concentrates

BY WAY of introduction to this paper a few of the requirements in a ration for dairy cows may be stated with benefit because these factors must be uppermost in one's mind when he is selecting and buying concentrates for his ration. Seven factors must be considered: bulk, digestibility, the "balance" of the ration, variety, suitability of the feeds, palatability and, finally, the cost of the ration. These factors should be thought of carefully in selecting concentrates. The "balance" of the ration and the cost are the two factors which will be explained a little further before making the selection according to prices. The other factors explain themselves in their names.

BALANCED RATION

To-day we have a somewhat different conception of the term "balanced ration" than was formerly held. In the past the term balanced meant practically the nutritive ratio of

the ration and nothing else. That is, a ration was said to be balanced if there was one pound of digestible protein to five and four-tenths pounds of carbohydrates and fat, 1 : 5.4. It was considered necessary to balance the ration quite closely. Today the best feeders agree that plenty of protein in a ration is fundamentally essential, but the range of the nutritive ratio has been set at wider limits. We now set the limits at 1 : 4.5 and 1 : 6.0. It is even thought that in sections where carbohydrates in feeds are the cheap nutrient that the wider limit may be wider than 1 : 6.0, although to the writer it would seem that a careful study of the paper on Manurial Values would show that wide rations for dairy cows would be advisable only under very exceptional conditions. The narrow limit 1 : 4.5 is set at that point purely because more protein than this may injure the health of cows. Many rations as narrow as 1 : 3.0 are fed. We have no adverse criticism of this practice. It is suggested, however, that cows on such narrow rations should be carefully watched.

The new thoughts of scientists, borne out by practical feeding trials, tell us that while the nutritive ratio and plenty of protein are important, some other things are also very important in a properly balanced ration. Much evidence is being brought out, particularly with growing animals, that not only is it necessary that there be sufficient protein present, but that the kind of protein is important. The importance of this in feeding dairy cows is apparent when we think that for nine months out of every twelve the cow is growing a young calf as well as caring for herself and manufacturing milk. The best way in practice to be sure of this point is to have a good variety in the ration with several plants represented. Later on we are going to know more definitely about the individual feeds and recommend specifically on this point, but at present we can only advise a variety of proteins.

Again the mineral matter in rations is receiving considerable attention and study. To insure a sufficient and suitable supply of mineral matter in the feed it seems absolutely necessary to feed legumes, and the most satisfactory legume from this standpoint is alfalfa. Therefore in our present idea of a balanced ration we must consider the individual feeds, the specific proteins that they supply and the mineral matter that they contain as well as the mere balance of the nutrients. I wish we might say specifically at the present time just what all these necessary things are and definitely

that this feed supplies this and that feed supplies some other necessary thing, but in the present state of our knowledge we can only urge variety and legume hays.

THE COST OF THE RATION

The other important factor on which the selection of feeds is based is cost. The proper way to select concentrates to supplement roughage is to start with the selection of the five or six feeds that are truly the cheapest on the market and then make up a proper mixture taking into consideration all the other factors.

To make this lesson clear and concrete we will take typical quotations and select the six feeds that are truly the cheapest. Those feeds are truly the cheapest which give us the most digestible material for one dollar.

The following table has been prepared to show which feeds at typical quotations give us the most digestible material for one dollar. This table has been computed both before the manurial value has been taken out and after on a net basis:

Feed	Price per ton	Pounds total digestible nutrients in 1 ton digestible nutrients	Cost of 100 lbs. total	Manurial value of 1 ton	Net cost per ton	Net cost of 100 lbs. total digestible nutrients
Corn meal	$35.30	1676	$2.09	$3.37	$31.93	$1.91
Hominy	33.00	1692	1.95	4.62	28.38	1.68
Gluten feed	28.75	1614	1.78	7.91	20.84	1.28
Malt sprouts	25.25	1412	1.79	10.10	15.15	1.07
Wheat mixed feed	28.00	1340	2.09	6.08	21.92	1.64
Flour middlings	30.25	1564	1.94	5.13	25.12	1.60
Distillers' dried grains	30.50	1778	1.72	9.43	21.07	1.18
Wheat bran	25.50	1218	2.09	7.81	17.69	1.45
Ground barley	35.00	1588	2.20	4.42	30.58	1.93
Ground oats	32.80	1408	2.30	4.53	28.27	2.00
Brewers' dried grains	27.50	1314	2.09	8.37	19.13	1.49
Cottonseed meal	37.00	1564	2.37	15.87	21.13	1.36
Oil meal	37.00	1558	2.37	11.87	25.13	1.62
Dried beet pulp	27.00	1432	1.89	3.01	23.99	1.67

The pounds of total digestible nutrients in one ton in the third column of this table are found by adding the pounds of digestible protein, the pounds of digestible carbohydrates, and the pounds of digestible fat after the fat has been multiplied by 2.25. This is the digestible material which we pay for. The rest, from the standpoint of the feeder, is waste. Then it is reasonable to select those feeds for the mixture of concentrates which will give the most digestible material for one dollar. To make this selection easy the fourth column is given. This column gives us the cost of 100 pounds of

total digestible nutrients in each of these feeds. **For example,** $2.09 is the cost of 100 pounds of digestible material in corn meal at the price given.

The second part of the table is computed to take into account the manurial value of the feeds. The manurial value has been computed with nitrogen at 18 cents per pound, phosphoric acid at 4.5 cents and potash at 5 cents, most conservative prices at present, and on the same basis as given in the article on Manurial Values.

Every farmer when he is thinking of buying feeds should prepare such a table with the prices submitted by the person from whom he expects to purchase. If one does not wish to do this for himself he should have his Farm Bureau Manager in his county do it for him or even request that his feed dealer do it for him to show him the feeds which are truly the cheapest. (Cornell Reading Course bulletin 117 gives all the necessary data for this.) The pounds of total digestible nutrients in one ton do not change, so may be used over and over again. This figure for any feed not in this list may be computed easily from any book or bulletin on computing rations. The column giving the manurial value per ton may be considered fixed, although these prices would of course vary with the price of nitrogen, phosphoric acid and potash. They are probably accurate enough for comparing the relative value of feeds.

SELECTING THE MIXTURE

On the basis of the cost of 100 pounds of total digestible nutrients the cheapest seven feeds, one-half the list, in order of cheapness are distillers' dried grains, gluten feed, malt sprouts, dried beet pulp, flour middlings, hominy feed, wheat bran. Not considering manurial values then, we would suggest the following as a good mixture:

500 lbs. distillers' dried grains
400 lbs. gluten feed
500 lbs. hominy feed
300 lbs. wheat bran
300 lbs. of oil meal

This mixture would contain about 23 per cent of total protein and would make a balanced ration with practically any kind of roughage. Two of the relatively cheapest feeds, malt sprouts and dried beet pulp, have been left out because the writer would suggest that if either of these be used that it should be wet up and fed separately. If a farmer does not have silage this would be the advisable thing to do. Feed the equivalent of three or four pounds of the dried pulp or malt sprouts daily and cut dry grain somewhat. Flour middlings are not used because bran is better and only

a little more expensive. Oil meal has been put in although eleventh in the list because of a personal liking for oil meal in a ration if not wholly out of the question on account of price. The oil meal would not be needed except for variety if silage is available and perhaps not needed at all if the beet pulp or malt sprouts are fed wet.

If manurial values are given credit the seven cheapest feeds in the list in order are malt sprouts, distillers' dried grains, gluten feed, cottonseed meal, wheat bran, brewers' dried grains, flour wheat middlings. The following suggestion is made on this basis:

400 lbs. distillers' dried grains
400 lbs. gluten feed
200 lbs. brewers' dried grains
300 lbs. wheat bran
500 lbs. hominy feed
200 lbs. cottonseed meal

Here again malt sprouts come high in the list and could be used to advantage fed wet. There are several factors against malt sprouts. Weed seeds are present many times, and may germinate after passing through the cow. Further, according to some authorities, the value of the protein in malt sprouts is not high. Therefore the use of malt sprouts may be more or less questionable.

This the writer offers as a basis for the proper selection of feeds. We invite criticism. It is merely a mathematical method of studying prices and the selection must always be modified by one's knowledge of what the feed will do. The writer has given one example in putting oil meal in the first mixture because he likes oil meal in a ration.

V. Forage Crops for Roughage

THERE is one great forage crop in the United States which is head and shoulders above all others except perhaps alfalfa. That crop is corn. Corn is king of the cereal grains and for all dairy farmers is king of the roughages. No dairy farmer can afford to continue without a silo. This statement cannot be made too strong. Therefore the main part of this article shall be a plea for silage on every dairy farm.

Early each spring every farmer should plan a crop of corn for next winter's feeding, and if he does not have one, plan to buy and build the silo in the late summer. Estimating thirty pounds per head per day for 180 days' feeding, a silo which will hold 100 tons will furnish silage enough for liberal feeding for a herd of 35 mature cows or the equivalent.

A silo 16 feet in diameter and 30 feet deep will hold upwards of 100 tons with some allowance for settling from the top after filling.

The yield per acre of good varieties of corn for silage on good land will average eight to ten tons per acre. Therefore plan for ten acres of corn if you have 35 cows, build a good silo and be on a firm foundation for feeding in the winter.

Silage is the cheapest forage that can be grown. To prove this a comparison is made with hay. Silage is worth for feeding, one-third the value of good clover hay. This is a safe and simple way of calculating the value of silage and may be shown to be true in several ways.

1. There are 354 pounds of total digestible nutrients in one ton of corn silage; in one ton of red clover hay, 1,018 pounds of total digestible nutrients. Therefore, on this basis three tons of silage are more than equal to one ton of hay. If hay is worth $12 per ton, silage is worth $4 per ton.

2. Look at the cost of production of silage. Can it be produced for $4 per ton?

The best estimate to which the author has access is the following table taken from "Feeds and Feeding" by Henry & Morrison. This shows the cost well below $4 per ton:

COST PER ACRE OF CORN SILAGE

	Minnesota 201 acres	Illinois 147 acres	Ohio 115 acres
Land rental	$3.75	$5.28	$3.31
Manure or fertilizers	.....	3.73	1.46
Seed	1.06	.42	.28
Labor growing and cutting crop	5.19	12.26	14.63
Labor filling silo	4.12		
Twine	.36	.41	.18
Coal	.42	.46	.25
Rental of power for cutter	1.39	1.21	1.36
Interest and depreciation on farm machinery	1.56	1.76	1.34
Miscellaneous	1.13	.58	.42
Total cost per acre	$18.98	$26.11	$23.73
Cost per ton, 10 tons per acre	$1.90	$2.62	$2.37

Computed in another way, one ton of silage in the corn belt will contain 5 bushels of corn at $.50, equals $2.50, plus $1 per ton of putting the corn into the silo, equals $3.50 per ton. This again checks below one-third the value of hay. Other methods may be used in checking up and in every case it will be found that silage is the cheapest roughage produced, considering its value from the point of succulence, which means health and milk with dairy cows, and food value.

A second great point in favor of silage is the cost and ease of storage. This is shown easily by a comparison with the storage of hay. A 100 ton silo 16 x 30 feet will have in it

6,040 cubic feet. To store the equivalent of 30 tons of hay will require 15,000 cubic feet of barn room at least as costly in construction.

This brings up the question of first cost for those who must build new silos. A careful study of the comparative costs of the different types of silos based on the 100 ton size yields the following data:

Wooden stave silos cost $1.50 per ton capacity; solid concrete type $2.50 per ton; cement block $4 per ton, and vitrified hollow tile $5.50 per ton. If we add this cost of the silo to the cost of production given above, a valuation of $4 per ton for the silage covers the entire cost of a stave silo in one year. Therefore can any dairyman afford to be without silage?

The next great question is the question of hay. Computed from the 1910 census, the following table gives the average yield per acre from alfalfa, clover, timothy and corn on an air dry basis:

RETURN PER ACRE OF ALFALFA AND OTHER CROPS

	Yield per acre, lbs.	Dig. crude protein, lbs.	Total dig. nutrients, lbs.
Alfalfa hay	5040	529	2672
Clover hay	2440	183	1263
Timothy hay	2440	68	1174
Corn (ears and stover)	3440	140	1964

This shows in no uncertain way why the acreage of alfalfa has doubled during the last ten years and put this crop ahead of any other dry roughage. Alfalfa hay forms the best supplement to corn silage. The man who has both alfalfa and corn silage has gone a long way in solving his feeding problems. Therefore after planning for silage all dairy farmers should turn their attention to the production of alfalfa. We need not go into detail. A glance which shows the comparative production of total digestible nutrients per acre and the comparative production of digestible protein is all that is needed. Then couple this evidence with the fact that the alfalfa crop is perennial through at least five years when a good stand is secured. Therefore the foundation is silage and alfalfa.

A very significant statement was once made to the writer by a New York farmer who had had much experience with alfalfa in the alfalfa belt. He said: "If you will do as much for the clover plant as you are willing to do for the alfalfa plant in the way of preparation of the seed bed, lime, etc., the clover plant will do as much for you." There is a chance for much reflection on this. We do a great deal for alfalfa. Perhaps if we were more careful of our clover and did a little

more for it, it would greatly repay us. This gentleman practices a short rotation of clover, potatoes, corn, oats and clover again. When asked if he did not want a hay crop which would stay down more than one year, he said he wanted the clover sod for his potatoes. On some fields he seeded timothy with the clover and used the timothy for a cash crop. Timothy and mixed grasses are a very poor substitute for clover or alfalfa hay for feeding dairy cattle.

Soy beans, cowpea hay and hay from oats and peas are all crops that may be utilized for a leguminous roughage for next winter.

Every breeder of Holstein-Friesian cattle should enter his animals for advanced registry. A valuable roughage to have on hand for this purpose to supplement silage and hay is roots. The best feeders advise the growing of the "Detroit Red" table beet for this purpose. Mangels will yield more per acre. "Norbiton Giant" is a large red variety of mangels for fall and early winter feeding, and "Golden Tankard" is a yellow variety which keeps better for late winter and spring feeding. Potatoes may be used, but ordinarily are not worth more than 15 cents a bushel compared with other crops.

Some interest is being shown in sweet clover and perhaps under special conditions this crop might be used.

Finally it may be said that the author wishes this thought to stick, that roughage for dairy cattle for the greatest and most economical production must come from a very few common crops, and every farmer must bend his energies to perfect his knowledge of the production of these rather than seek new crops. These crops are: 1. Corn for silage. 2. Alfalfa hay, or, failing this, clover hay. 3. Roots for special high production of milk.

Nothing has been said on varieties except for roots or on cultural methods. It is hard to make general statements on these points in a short article. The author prefers to leave these points to individual inquiry when the local conditions pertinent to each farm may be stated.

VI. Curing Hay from the Standpoint of a Feeder

THE farmer who raises hay to feed to his own stock has a different problem from the farmer who raises hay to sell. The latter has only one object in view, to raise as much dry weight per acre as he can, of a quality which will command a high price. The feeder is raising as much forage

as he can per acre most economically; he wishes to have the hay as highly digestible as possible and as palatable as possible.

The ideal hay from the feeders' standpoint must be bright in color and have a fine clean aroma. These two factors are important to make the hay properly palatable. If the hay is to be highly digestible all of the leaves must be retained. This is an important factor in the curing of all legumes. It has been found at the Colorado Experiment Station that 40 to 60 per cent of the weight of alfalfa hay is in the leaves. In these leaves are four-fifths of the protein and more than one-half of the carbohydrates other than fiber, and more than one-half of the fat. By careful work it was found that under very favorable conditions, for every ton of hay taken from the field, 350 pounds were lost in the leaves broken off. In one instance,under unfavorable conditions, for 2000 pounds of hay cured 3000 pounds were lost in broken leaves and stems, that is more was lost than saved. The portion saved under such conditions is the less valuable part, the woody stems and coarser leaves. The leaves of timothy and other grasses do not break off easily.

The last factor of great importance is the freedom from dust and mold. Under some circumstances on land that has flowed or on new seeding the hay may be very dusty and dirty due to dirt from an external source. But most of the dust in hay comes from the growth of bacteria and molds. These can only be kept down by proper care in curing.

With this introduction we may divide the rest of the discussion into two parts: 1. Some of the methods used in making hay. 2. When to cut timothy, clover and alfalfa as typical hay crops most generally raised.

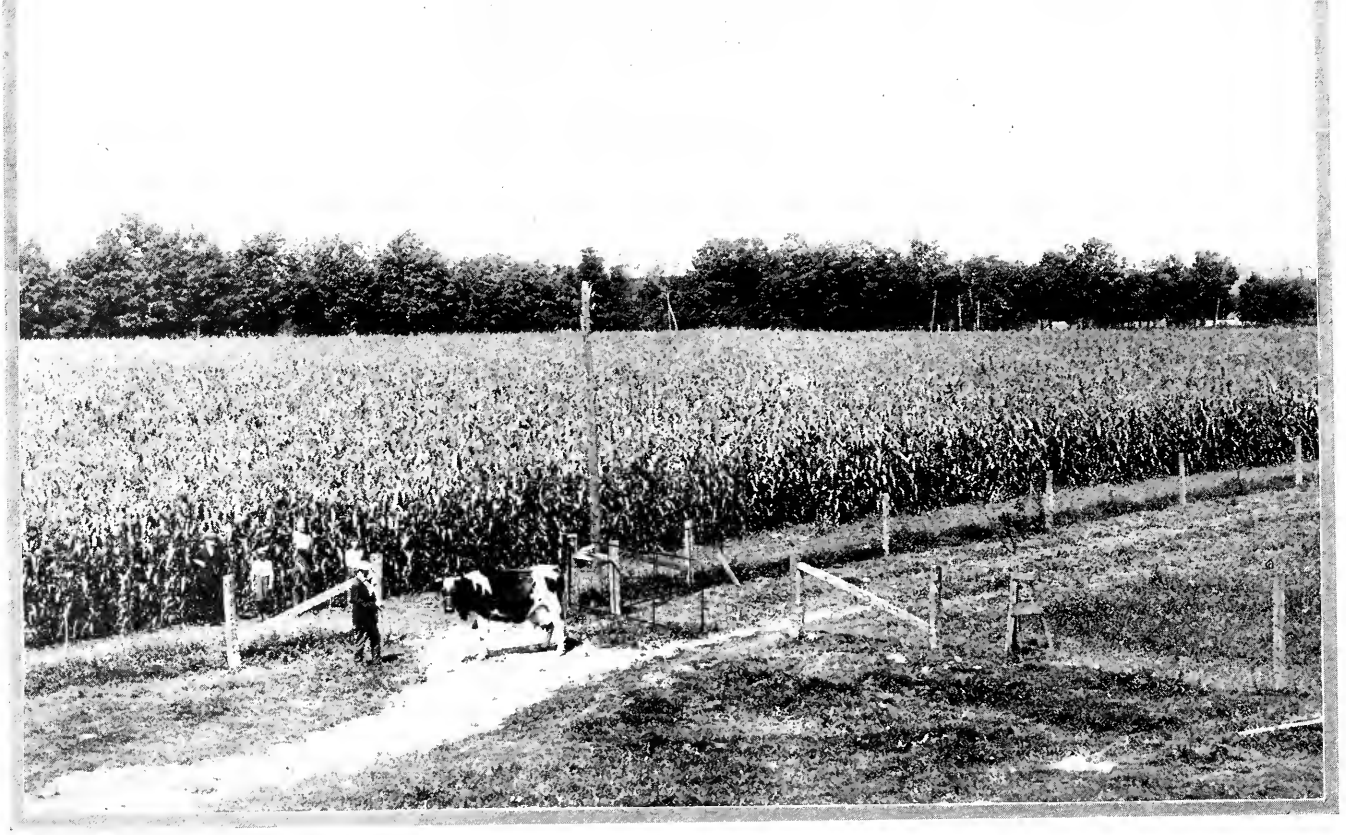
Three things must take place in making hay: 1. The water content should be reduced to somewhat below 20 per cent. There is some fermentation going on, caused by bacteria. 2. The curing process must control this so that the aroma of the hay will be best to make the hay palatable and so that there will be practically no dust. 3. Hay must be exposed as little as possible to the sun to prevent bleaching. This is again important from the standpoint of palatability.

Careful experiments have been made which show that dried grass has the same nutritive value as fresh grass. Two portions of the same field have been cut and equal amounts fed to a cow, one portion fresh and an equal portion of the fresh material carefully dried before feeding. The milk production was the same. In all practical cases, however, one

cannot cure hay without some exposure and loss, therefore the cured hay never has quite the same feeding value as the fresh material. The loss from the sun is comparatively small. The greatest loss always occurs when bleaching takes place from rain. In one experiment hay exposed to three rains lost 60 per cent. of the crude protein, 41 per cent. of the carbohyrates other than fiber, and 33 per cent. of the fat. In this case 31.7 per cent. of the total dry matter was lost.

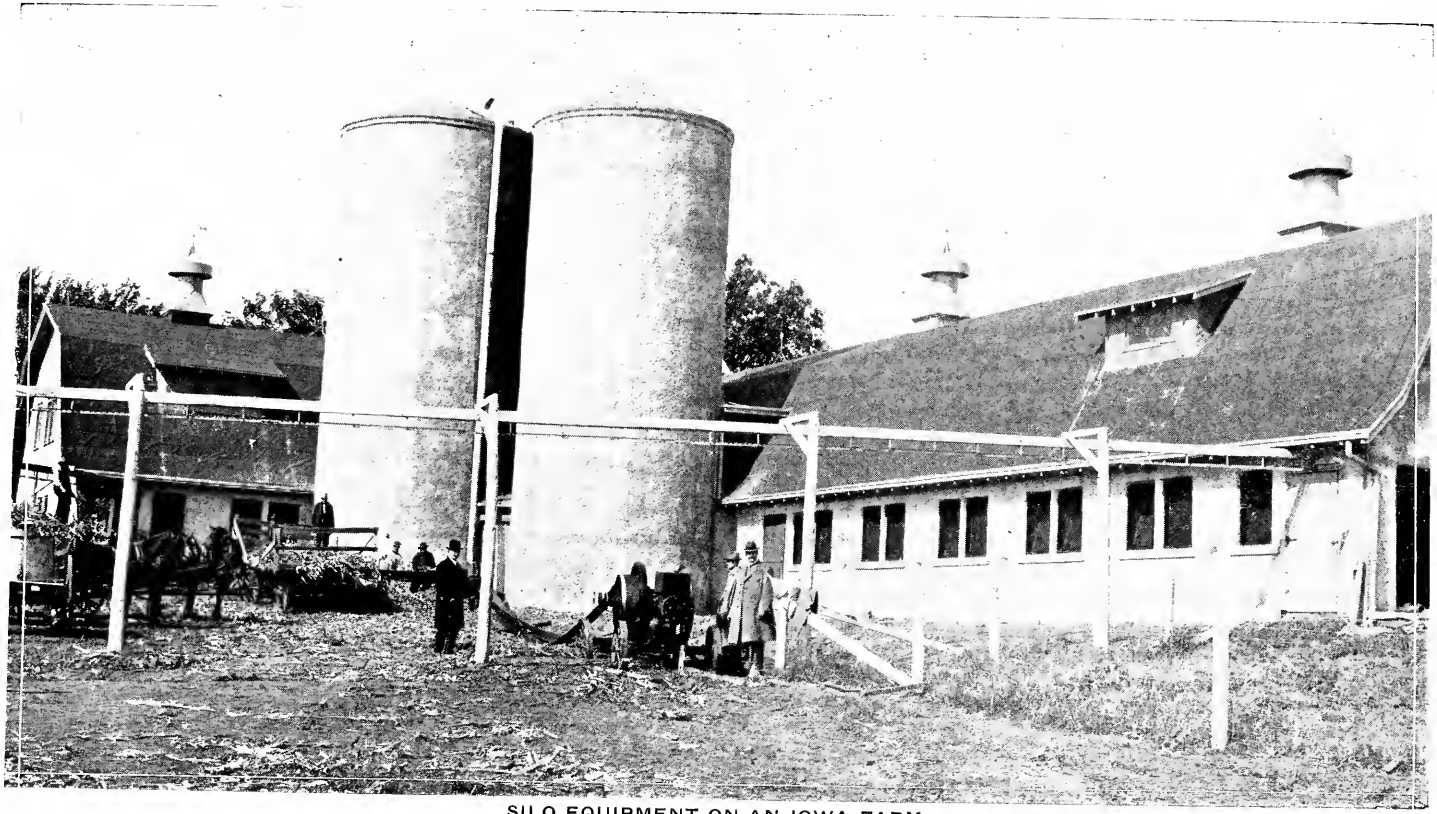
It is difficult to write any method of curing. Probably the ideal way to cure hay, particularly clover and alfalfa, is to mow after the dew is off, then rake and cock the hay when well wilted and while hot. Cock into small cocks. Then open out the next day or the second day in large flakes, shaking the hay as little as possible to prevent loss of leaves. The main reason back of this process is that the leaves and stems are still alive until nearly dry. The life processes still go on and the one that helps in the curing is that the water continues to move from the stems to the leaves. If the hay is allowed to wilt too much the leaves will become completely dry before the stems have dried out sufficiently. When well cocked this movement of water will continue and leaves and stems all drop out together. In the cock, too, about the right amount of fermentation will develop to give the hay its best color and aroma. Of course by this method bleaching is reduced to a minimum. If hay caps are used perhaps it is best if the cocks are not disturbed at all the day after the hay is cut. Many times the cocks may be opened after the dew is off the next morning and the hay sufficiently cured to be stored the day after it is cut. A modification of this method is to cut the hay in the late afternoon, cock up the next day and house it the next. In good weather these methods work out very well.

Any modification in the interest of speed and economy almost always means curing in the windrow without cocking. This is all right for mixed grasses, timothy and all hay with a minimum of legumes in it. But methods involving frequent tedding and much exposure to the sun, cause bleaching and then in case of rain the very greatest loss because of the maximum surface exposed. Exposure to dew is always bad except when freshly cut. When cut in the late afternoon the first night's exposure to dew does little harm. A more extensive use of hay caps in the curing of legumes will improve the quality of our legume hay very much. Hay should be put into the barn as dry as possible but at the same



CORN FIELD AT ROYCROFT FARM, ONTARIO, CANADA

Roycroft Mildred, world's champion 4-year-old milk producer in the foreground. "The dairyman should make ample provision for each year's corn crop in his farming operations."



SILO EQUIPMENT ON AN IOWA FARM

The silo is the badge of the dairyman. Silage is the dairyman's most economical feed.

time there must be moisture enough to cause the hay to pack well. The ability to decide just when hay is right to go in is an art and no rule can be given. Authentic instances of spontaneous combustion are on record, therefore one mus. take no chance by puttng in the hay too green.

WHEN TO CUT TIMOTHY, CLOVER AND ALFALFA

The proper time to cut hay is when the largest yield per acre can be obtained commensurate with highest quality. With timothy hay this is when in full bloom. The Missouri Station in an experiment showing average results for three seasons gives us the best data:

YIELD OF TIMOTHY CUT AT DIFFERENT STAGES

	Dry matter per acre ,lbs.	Total digestible matter, lbs.
Coming into blossom	3411	1908
Full bloom	3964	2113
Seed formed	4089	2030
Seed in dough	4038	1914
Seed ripe	3747	1754

It will be seen that at full bloom the most digestible matter is yielded. The farmer who wishes to sell his hay would not cut it until after the seed had formed in order to get the greatest yield of dry matter per acre. Practice tells us that for feeding most animals the early cut timothy is the best. Horses, however, may utilize to good advantage hay cut later. A like table from Illinois and Pennsylvania gives comparable results on red clover:

YIELD AND NUTRIENTS IN AN ACRE OF MEDIUM RED CLOVER.

Stage of growth when cut	Yield of hay per acre, lbs.	Total nutrients, lbs.
Illinois—Hunt:		
Full bloom	3600	2309
Heads three-fourths dead	3260	2231
Pennsylvania—Jordan:		
Heads in bloom	4210	3419
Some heads dead	4141	3202
Heads all dead	3915	3153

This shows that the proper time to cut clover is when in full bloom.

With alfalfa a different problem is involved. Here the second crop must be considered. Two general rules are observed: 1. Cut when about one-tenth in bloom. 2. Cut when new shoots appear at the crown. In general it seems best to observe the second rule in the interest of the next crop. In many sections it is practically impossible to cure the first crop of alfalfa. Although apart from the subject of hay making it may be mentioned here that one way to conserve this first crop under unfavorable weather conditions is to put it into the silo as one would put in corn. The resulting silage is not as valuable as corn silage but is a valuable silage nevertheless.

Finally, not enough thought is given to the relation between quality of hay and its nutritive value. High nutritive value is always found in the best cured hay. Hay making as an art or science is something more than simply getting the hay dry enough to go into the barn.

VII. When to Cut Corn for Silage

THE determination of the proper time for cutting corn for silage has passed through an interesting history.

When silage was first made it was thought that the corn plant must be very green in order to make proper silage and much of the valuable part of the crop was lost as we shall see. As silos have become more and more common the corn plant has been harvested later and later, until now it is the custom, and the proper one, to wait as long as possible in order to get more maturity, with increased keeping qualities.

In order to study the subject carefully and to find out the reason for the practice of waiting until the corn is as near mature as possible we must study the nutrient content of the corn plant at different stages of maturity.

This is best shown in a table taken from "Modern Silage Methods", published by the Silver Co., Salem, Ohio:

CHEMICAL CHANGES IN THE CORN CROP

Yield per acre	Tasseled July 30 lbs.	Silked Aug. 9 lbs.	Milk Aug. 21 lbs	Glazed Sept. 7 lbs	Ripe Sept. 23 lbs.
Gross weight	18045.0	25745.0	32600.0	32295.0	28460.0
Water in the crop...	16426.0	22666.0	27957.0	25093.0	20542.0
Dry matter	2619.0	3078.0	4643.0	7202.0	7918.0
Ash	138.9	201.3	232.2	302.5	364.2
Crude protein	239.8	436.8	478.7	643 9	677.8
Fiber	514.2	872.9	1262.0	2755.9	1734.0
N. F. E. ..... (Starch, sugar, etc.)	653.9	1399.3	2441.3	3239.8	4827.6
Crude fat	72.2	167.8	228.9	260.0	214.3

A careful study of this table will show some very interesting things. The huge increase in the amount of dry matter per acre comes between the milk stage and the glazing stage. There is a still further increase before ripening. After the glazing stage there is a change in the carbohydrates. The amount of fiber per acre drops more than 1000 lbs. before the corn is ripe, and the more soluble carbohydrates, starches, sugars, etc., increase more than 1500 lbs. An increase in the dry matter per acre, with every day up to maturity, tells us that the later we put off putting the corn into the silo up to the time the corn is ripe, the more food per acre we are getting in our crop. All groups of nutrients except the fiber show an increase with every day and the loss in fiber is more

than made up by the increase in other carbohydrates. Fiber is the hardest nutrient to digest and the percentage of fiber that is digested is less than the percentage of any other nutrient. Therefore the total digestibility of the corn plant will increase towards maturity.

From the average of twenty-one careful trials, with more than twelve different varieties of corn, it has been found that between tasseling and ripening the dry matter in the plant will increase 193 per cent., the crude protein 98 per cent. These averages have been compiled from several sources and bear out the statements given in detail above in the table. It is seen that when the plant has reached its full height, it has really only begun to store up food for use in the form of silage. These tables show conclusively how foolish it is to grow corn of large varieties for silage, and how much better it is to plant the corn no thicker than to allow it to mature fully, with the largest possible proportion of ears.

Therefore, due to the larger proportion of food value as corn approaches maturity, we can say without any doubt, that the time to cut corn for silage is as near maturity as possible. The only reason for not waiting until the corn is ripe is that there is danger that the silage may not pack well. This may be overcome in part by the addition of water, as will be discussed under treatment suggested for frosted corn.

A third reason, apart from the increased amount of nutrients and less fiber, is in the fact that there is more of the carbohydrates in the form of starch as the plant approaches maturity than in the form of sugar. This fact has an important bearing on the keeping quality of the silage. The more sugar there is present the farther fermentation will go and the more acid will result. The better quality of silage is that that is least acid. Then, too, the losses in food value which occurred in the silage after it was stored in the silo, in the early days, often ran as high as 20 per cent. According to the best authorities, the loss need not be above five per cent. if the corn is reasonably mature before cutting and the silage is properly packed. The writer has many times seen gallons of liquid nearly of the consistency of syrup, run out from the bottom of silos when the corn was put in too green. The silage in such a silo is sure to be very acid. While not injurious, acid silage is not so palatable, certainly not so nutritious, and indicates that there has been a greater loss than necessary in the silage after storage.

SILAGE FROM FROSTED CORN.

In the colder parts of the top tier of states in the United States, if we are going to leave our corn in the field until it is fully glazed, or even later, often it is going to get frosted. There is now enough experience on this point to enable us to say that frosted corn will make just as good silage as other corn if properly cared for. First, the corn that has been frosted must be cut at once, because if left in the fields it will shatter and lose some in this way if it dries out too much. Then if the frosted corn is rained on very much the same losses will occur as would occur if the corn were cut and shocked.

When frosted corn is cut into the silo water enough must be added to make the silage pack well. Practically it is nearly impossible to do this unless the blower type of silage cutter is used. Then the water is introduced into the blower and the silage is thoroughly and evenly wet. Water enough will be added if a good stream, without much pressure, is run into the blower with a three-quarter-inch hose. The writer has had two years' experience with silage made from frosted corn in this way and when fed it could not be distinguished from ordinary silage.

We would advise, then, that when there is a blower cutter available and a stream of water that can be introduced into the blower, corn should be allowed to mature beyond the glazed stage before it is cut. We would even suggest that some chance be taken with early frosts in order to get a more matured plant with the very evidently greater food value than there is if cutting is put off until the kernels are fully glazed.

VIII. The Ideal Ration For a Dairy Cow

THE point of view in this paper is the proper ration for a dairy cow after she has freshened and is in full flow of milk. How shall we feed her to get maximum production? Farmers wish to know what is the "best" dairy ration. The answer must always be in terms of the surroundings on each person's own farm. Perhaps it will be best to begin the discussion with a definition of the "best" dairy ration. That ration is the best which will bring about the greatest producton at the least cost, and in looking at production in these days we must look at the records that the cows make as well as the actual milk produced. There is more money in the record and in the offspring than in the

milk itself. The best breeders of purebreds look at the milk as a by-product.

Before the ration itself can be considered, a breeder must look to the conditions surrounding his herd. We will only stop to consider these for a moment and just barely call attention to them. These things are five: kindness, light, pure air, pure water and an abundance of salt.

Every animal in a dairy herd, which is well managed, will be so tame that the owner and attendants may catch her easily at any time in the open lot. A dog, be he ever so gentle, is of little use in connection with a dairy herd. A club or whip has no place in a dairy barn.

Light and ventilation explain themselves. We must supply all the light and pure air possible. It is not costly to provide light in a stable, neither is it very costly to provide very efficient means of ventilation in old stables if the owner is a live, hustling manager with his mind open to the best in his power for the comfort of his animals. All the dairy papers and experiment stations are ready at any time to help and suggest means of bettering stable conditions with plans which may be had for the asking. Most of these plans are simple and economical and farmers are fully capable of putting them into execution.

Cows should be watered at least twice a day. The water should be pure and at all times of year it should be free from ice. If cows have a place to drink where ice does not form, and when they are watered twice a day, it does not seem necessary to artificially warm the water. The danger is to avoid chilling the animal so that she will not have to stand and shiver after drinking. Any system which will furnish pure water and which works so that the cow gets all that she requires, at least twice in twenty-four hours, is a good watering system.

A cow should be furnished with about one ounce of salt every day. The practice of our best dairymen varies. The writer would suggest feeding each cow about two ounces three times a week, either in the grain feed or simply thrown into the manger any time during the day. So much for five fundamental conditions which must be made right in every herd for the best results. We may now turn our attention to the consideration of the ration itself.

In this series of papers on feeding we like to be definite even if the papers are not so smooth in their general effect. In considering the formulation of an ideal ration, there are seven factors, that should be considered. They are:

1. Bulk.
2. Digestibility of the feeds.
3. The relation of the nutrients—that is, the "balance" or nutritive ratio of the ration.
4. The variety of feeds.
5. The suitability of the feeds to the animal and the products.
6. The palatability of the feeds.
7. The cost of the ration.

1. Bulk. Dairy cattle demand a certain amount of bulk in the ration. This is secured by feeding succulent feeds. Dry grain and hay do not meet this condition or factor. Therefore silage or roots must be fed, and to meet ideal conditions we must furnish both. This is closely connected with the factor of palatability, a succulent ration is more palatable to a dairy cow. A good definite rule is to feed one pound of dry roughage per hundred pounds of live weight. When feeding both silage and roots, more than this may be advisable.

2. Digestibility. We should always try to arrange the crops so that the most highly digestible feeds will be available. Roughage must be fed, but the hay must always be well cured. There is probably no chance for straw in an ideal ration. The concentrates must not be too bulky. About one pound to the quart is a good rule to follow in the mixing of grain rations.

3. Relation of the nutrients. Much has been said concerning the balancing of rations and the nutritive ratio. The writer believes that the nutritive ratio should not be outside of 1:4.5 to 1:6. This means one pound of digestible protein to 4.5 pounds to 6 of digestible carbohydrates and the fat in the ration. Most farmers do not care to compute the nutritive ratio of their ration or have not learned to do so. It is advisable to know this because this relation is very important. However, if we make sure that at least one-half the grain mixture is made from foods containing 20 per cent. of crude protein, the nutritive ratio will fall between the limits 1:4.5 to 1:6 in almost every case.

4. Variety. No ration has sufficient variety unless there are three grains in the mixture. A good check is to have three or more grains in the mixture and to have at least four plants represented in the whole ration, taking into consideration in this check both the roughage and the concentrates. This is important in getting a sufficient amount of mineral matter and all the different nutrients required.

5. Feeds suitable to the individual animal and to the product are always necessary.

6. Palatability is very important in large production. Here is the place where the individuality of the animal is concerned. In a general herd ration, if there is succulent food in abundance at all times of year, the ration will be palatable to practically every individual and it is probably not worth while to have more than one general mixture. In feeding a cow an ideal ration for a special record, it is best to study her whims and personal likes. If roots can be provided, the most palatable way to feed the grain is on sliced roots.

7. Most important of all to most farmers is the factor of cost. The more valuable the animal and the more we can get for the offspring, the less we need to look at the cost of the ration. If a man is keeping the cows that meet the ideal that he should have, he can afford to feed them all they can eat of the very best foods all the time. However, ideal rations may be selected with a great deal of attention paid to relative costs. The method of choosing concentrates has been given and need not be repeated here.

Lastly, must be mentioned the amount to be fed. On full production with good cows, it is hardly necessary to mention this—it will be found the most economical practice in the end to feed for the first six months of the lactation period all the grain the cow can consume. Of course, this means all she will consume according to her normal appetite and does not mean crowding. About one pound of grain to three and one-half pounds of milk will ordinarily be sufficient.

With the above rules in mind, the following ration is suggested as approaching the ideal for a cow weighing 1100 pounds and producing forty pounds of milk per day, testing 3.5 per cent. butterfat:

10 pounds alfalfa hay
30 pounds corn silage
30 pounds mangels (sliced)
12 pounds grain

This grain mixture is suggested:

500 pounds distillers' dried grains
300 pounds gluten feed
200 pounds wheat bran
200 pounds ground oats
400 pounds hominy feed
200 pounds oil meal
200 pounds cottonseed meal

The writer is fully aware that in the above, the oats, the oil meal and the cottonseed meal are high in price, but in this

paper the ideal ration is being considered, and the above ration is the best that we know how to put together.

For those who would not wish to mix so complicated a mixture, the mixture given before will check with the factors concerned:

500 pounds hominy
500 pounds distillers' dried grains
500 pounds wheat mixed feed
300 pounds gluten feed
200 pounds oil meal

If roots are not available it might be well to purchase dried beet pulp and soak up about three or four pounds per cow and feed the grain on this soaked beet pulp in place of sliced roots.

In case no roots or beet pulp are fed, a little more grain would be advisable.

IX. Feeding in Summer

A DAIRYMAN thinks about his cows relatively little in summer. He gets up in the morning, milks them and turns them out, takes the milk to the milk station and ships it and takes what he can get for it, trusting that the Dairymen's League will market his milk for him to the best advantage. He then does his farm work during the day and gets the cows up again in the afternoon, milks them and turns them out nights, if he thinks he can find them all right in the morning. If they fall off in milk and get a little thin, he does not think much about it except momentarily. The hair is smoother and the skin is more mellow, the general physical condition is much better and the owner does not realize that his cow is really going down in flesh.

The cow on the other hand, is likely to find the summer season one of little relief to her. She is required to get out and gather her own meals, in many cases does not have proper relief from heat, through good shade, and in any case has to fight the flies. If she is a fall cow, she is not only supposed to produce highly, but she is supposed to grow her calf. All these duties and troubles pull her down. She puts all she can into the pail, because good pasture is a great incentive to high milk production. However, during July and August, she is likely to slacken up.

GRAIN MIXTURES FOR COWS IN MILK

It is the writer's belief that the best outlay of money for feeds is that expended for the grain which is given to cows and young stock while on pasture after the first of July. There is no evidence to support the feeding of much grain

to cows and young stock previous to the first of July, when the pasture grasses begin to dry up. During flush of pasture, when the grasses are at their best, cows will eat enough of them and make the best use of pasture, unless they are extremely high producers. In that case, the chances are that the animal will not have the capacity to hold enough of the green grass to furnish her with the material from which to make large quantities of milk. But the general run of cows will be able to produce 40 to 50 pounds of milk a day on pasture grass, during June.

Now, the thing to do is to keep these cows producing during July and August at the same rate. The first thing to do is to spray the cows thoroughly. We cannot recommend any specific mixture. There are several on the market and the writer has tried out two or three of them with good succcess. About all one can do is to pick the best one he knows and use it as intelligently as possible. It is probably not possible to spray the cows more than once a day after milking in the morning and again at night.

The mixture of concentrates to be fed on pasture does not present a very serious question. Enough must be fed with the green crops or silage to maintain the milk flow. Do not let the cows shrink. A somewhat heavier mixture may be fed than in winter if the market considerations should demand such. The concentrates should be chosen as indicated in the earlier articles in this series. High protein feeds should constitute one-half the mixture of concentrates and bulky foods about one-third the mixture by weight. If the market would indicate such a choice, the following would serve the purpose to good advantage:

500 pounds corn meal
400 pounds distillers' dried grains
500 pounds mixed feed
400 pounds gluten feed
200 pounds cottonseed meal

Some authorities think it is not necessary to make a high protein mixture for pasture feeding, because the pasture grass as taken by the cow provides more protein than hay. Therefore, we can make good use of the cheaper wheat feeds and corn feeds.

A mixture I am suggesting for dairy cows in summer to make a larger use of wheat and corn feeds is as follows:

300 pounds wheat bran
300 pounds hominy
300 pounds gluten
100 pounds oil meal

Sometime ago, the Cornell University Experiment Station made quite an extensive study of the feeding of concentrates on pasture. To briefly summarize the result of their experience we would find about what has been suggested, that during the flush of pasture the extra material obtained, did not pay for the feed, but after the flush was over, that grain feeding paid.

There is a secondary result from the feeding of grain on pasture. It was found in the Cornell experiments that in the second year the cows that had received grain while on pasture the year before, did better than those that received no grain. The second summer all cows were fed alike, all cows being fed grain on pasture. The previous year one group had received grain and the other no grain. Professor Roberts was certain that the feeding of grain to one group carried over into the next summer. Professor Roberts holds, that the benefit of pasture was an especially marked one in the development of the young stock. This showed up in their greater production, greater size and stretch over those receiving no grain on pasture.

Professor Eckles, in his book gives the following table for feeding a Holstein cow on pasture:

25 pounds milk daily	3 pounds grain
30 pounds milk daily	4 pounds grain
35 pounds milk daily	5½ pounds grain
40 pounds milk daily	7 pounds grain
50 pounds milk daily	9 pounds grain

This, of course, applies only when pastures are abundant. The poorer the pasture the more necessary would be the feeding of grain and the amounts would approach the amounts fed in the winter.

GRAIN MIXTURES FOR YOUNG CATTLE

We know of no grain mixture for young cattle on pasture which is any better than the following:

30 pounds wheat bran
30 pounds ground oats
30 pounds hominy
10 pounds oil meal

A good mixture without the oats would be:

300 pounds wheat bran
500 pounds hominy
200 pounds oil meal

X. Succulent Feeds to Supplement Pasture

IT IS a well known fact among dairymen that cows that once go down in milk do not readily come back again. It does not seem to be enough, however, to feed concentrates entirely as a supplement, nor is it economical to do so.

It seems to be as necessary to provide succulent feed, concentrates and perhaps some dry roughage, at this time when the cows are on pasture, as it is in winter when the cows are in the barn.

The writer is of the opinion that it is good practice to feed some hay in summer when the pastures begin to go dry. Some dairymen think it best to feed a little hay even at the flush of pasture. The writer is of this opinion but does not urge the practice, but would merely call it to the attention of dairymen as a subject for thought and perhaps trial.

We are convinced, however, that the cheapest and most convenient way to supplement pasture is to feed silage. Here are some of the reasons: First, it has been conclusively demonstrated in several trials that the cows will produce as much, seem as comfortable and keep up their appetites just as well when fed silage and grain and perhaps a little hay when on pasture, as when fed green crops, grain and hay when on pasture. Second, from any experiments that the writer has seen, the cost has always been in favor of the silage.

There is every reason to believe the two main facts just cited. In addition: (1) It is difficult to get proper succession of crops so that each is in its choicest condition when fed. Some crops will have to be fed when a little too green, others will have to be held too long. (2) It is necessary to plant small areas at different times, which is a nuisance in busy seasons. (3) When pastures suffer from drought the worst, and green crops are most needed, the green crops also yield poorly. With silage, an abundance of succulent feed is carried from year to year, and the effect of drought easily and most economically offset. (4) Green crops must be harvested in small quantities in all kinds of weather. It is practically necessary to harvest some every day because it is impossible to pile them even in small piles without some loss in palatability.

When silage is grown large fields are fitted most economically. The best use of labor and machinery is made in planting, cultivating, and harvesting the crop. Silage is of uniformly high quality at all times. Greater yields per acre are obtained with silage than with many crops used in a green crop system.

The only reason the author can find in favor of the growing of green crops, to supplement silage, is the value of variety in the ration, and the fact that it may not be best to feed a cow continuously on silage the year round. She will

get some rest, however, in a system with silage as the only supplement, because in nearly every locality there is a flush season of pasture when probably neither a succulent supplement nor a grain supplement will be needed.

The method of supplementing pasture with silage alone, grades into a second plan which involves the intermittent use of the silo. Advantage is taken of alfalfa and clover and a crop or two of peas and oats, when these crops are in prime condition, and silage is used in between. There will be some loss of silage in intermittent use, but the amount is small when the silage is near the bottom of the silo, because it is so tightly packed and fermentation has stopped. Care should be taken to keep the surface of the silage level, and to leave it as smooth and as little disturbed as possible when pitching off the last lot, when planning to use a green crop for a time. This plan has been used at Cornell University with success and with little loss. Whichever plan is used, the greatset success will be obtained if two silos are available, one with a larger diameter for winter feeding and one with a less diameter for summer feeding. The smaller the diameter the less surface will be exposed at any time and consequently the less chance of loss.

The third method of supplementing pasture will involve the use of green crops alone, and means a succession throughout the summer from about July 1st to November 1st. Such a succession may be obtained with the use of the following crops. The table is computed on the basis of the needs of 50 cows. The table is adapted from a table given in "Feeds and Feeding", by Henry and Morrison, and is quoted from Professor Voorhees of New Jersey. This plan, then, would be applicable to the latitude of southern New York, New Jersey, Pennsylvania, Ohio, etc.

Crop	Acres	Date of seeding	Period of cutting
Peas and oats	2	April 2	June 26-July 4
Peas and oats	2	April 11	July 5-July 10
Peas and oats	5	April 19	July 11-July 22
Southern white corn	2	May 2	July 23-Aug. 3
Barnyard millet	2	June 19	Aug. 4-Aug. 19
Soy beans	1	June 1	Aug. 20-Aug. 25
Cow peas	1	June 10	Aug. 26-Sept. 1
Second cutting clover or third cutting alfalfa		.....	Sept. 2-Sept. 16
Pearl millet	2	July 1	Sept. 17-Oct. 1
Cow peas	1	July 24	Oct. 1-Oct. 5
Mixed grasses		.....	Oct. 5-Nov. 1

It is not claimed that the above outline is the best that may be suggested. It is merely a suggestion to indicate the crops that may be used for the purpose discussed in this

paper, with the probable acreage needed for fifty cows, the time of seeding, and the approximate time when the crop would be in prime condition to be fed green. Each individual dairyman must work out his own system. All dairymen must feed some supplementary feeds and can best plan their work through the use of silage.

Attention should be called to the amount of succulent forage crop that must be fed to secure the best results. In the winter time we are accustomed to feed a cow 12 pounds of hay daily and 35 pounds of corn silage together with a good grain mixture. Twelve pounds of hay daily would yield 10.5 pounds of dry matter; 35 pounds of corn silage would furnish a cow with 9.2 pounds of dry matter; therefore, with this ration of hay and silage, she would be getting approximtely 20 pounds of dry matter of the roughage a day.

Suppose that when on rather fair pasture in July and August she gets one half of the necessary dry matter in the roughage. That means we must feed enough silage crop or green crop to furnish 10 pounds of dry matter a day. Now let us see how much of these succulent feeds will be needed to furnish this 10 pounds of dry matter. Peas and oats, green, have 22.6 pounds of dry matter in a hundred pounds; green alfalfa about 20 pounds; green clover about 20 to 25 pounds; millet about 21 pounds; the corn fodders in the tassel and milk stage about 15 to 20 pounds. Therefore, it will be seen that to furnish this 10 pounds of dry matter, not less than 40 pounds and in most cases, 60 pounds of fresh, green roughage must be fed. I think that most feeders do not realize this and are accustomed to feed a little of green stuff once a day and expect a cow to get a whole lot out of it. If you are going to provide green stuff for cows and young stock, feed them liberally.

XI. Molasses as a Feed

THIS year, 1921, due to business conditions in general and the sugar manufacturing business in short, molasses has been a cheap feed and its sale is being pushed rather hard by the different sugar and molasses companies. Now, molasses is like every other feed. It is a valuable feed, if it does not cost you very much and you should be posted as to its relative value. In this article, I will endeavor to give some facts that may help.

CANE MOLASSES

When buying molasses, one should buy it with careful attention to its composition and guarantee, just as in buying

any other feed. A good cane molasses should have not over 21 to 22 per cent. water, not over 6 per cent. ash and not less than 53 to 55 per cent. total sugar.

The total digestible nutrients in molasses of about this composition add up to 1184 pounds to the ton. This shows that on the basis of digestible material, molasses is worth just about three-fourths the value of corn meal, and the price one should pay for it might very well be based on this comparison. Another comparison would be with wheat bran. There are in one ton of wheat bran, 1218 pounds of total digestible nutrients. Therefore, one could not afford to pay more per ton for molasses than good wheat bran. The wheat bran has the added value of considerable protein and mineral matter, which is not supplied in the molasses, the value of the molasses being almost wholly in its sugar content.

Of course, there is a value in molasses in that it tones up the whole digestible system and keeps the bowels of the animal in a free and open condition. Because of this physiological effect and the fact that molasses helps to smooth up the hair and make the skin more mellow, the first pound of molasses that one feeds is more valuable than any other pound. Therefore, as a conditioner, a little molasses in the ration may be very valuable. This is particularly true if one does not have corn silage.

Molasses is very valuable in feeding cows on advanced registry tests and no feeder of a cow on test either for a short or long period, tries to feed without molasses. It is not usually fed to these test cows in a large amount, but is used to the extent of two or three pounds daily. The molasses is usually diluted with water, and the water used to soak up beet pulp. A customary dilution is one quart of cane molasses to ten quarts of warm water. Used in this way, molasses is very valuable indeed, and is sought for, for this purpose. irrespective of cost.

In ordinary every day feeding, molasses is a little difficult to handle, unless one has a supply of hot water available at all times. I think that it is good practice to feed all animals a little molasses, particularly at the price that it can be bought at this time (1921).

I do no think much of beet molasses, and I see no reason for feeding it. The difference between beet molasses and cane molasses is largely in the high content of alkaline salts. These salts cause the molasses to have a purgative action, and I would not advise the feeding of beet molasses when cane molasses can be obtained.

XII. The Feeding of Lime and Phosphorus to Dairy Cows

INTEREST changes in the different sides of the feeding question. For many years the question of greatest importance in the feeding of dairy cows has been the amount of protein. The whole question of the balanced ration lay in the proper porportion of protein to the other nutrients, and a ration was said to be balanced if it had the proper nutritive ratio. During the war, this question changed somewhat due to the fact that the cost of high protein feeds became much less than in any pre-war days, and the question of getting enough protein into the ration was not so much of an economic question as it had been before. Farmers became accustomed to buying quite extensively of high protein feeds and putting them into their rations. Further, the teaching of agricultural colleges and experiment stations, the large amount of publicity given in the dairy papers to the rations used by the best feeders, has caused most farmers to use feed mixtures containing an abundance of protein.

Just now the question of the proper balancing of a ration is spreading out into a discussion of the necessity for vitamines and the necessity for mineral matter. The question of vitamines in the feeding of farm animals probably will never be a very serious one, because of the fact that farm animals get a large amount of roughage in their ration and there seems to be plenty of vitamines present in the roughages and other feeds that are the normal ingredients in rations. The question of the proper amount of mineral matter in the ration is now receiving considerable attention. The question of mineral matter with the proper feeding of swine has always been considered important, but the question of the proper mineral matter in the rations for dairy cows has not received the attention it should, until very recently. It is the purpose of this article to summarize the knowledge up to date and to state specifically how the mineral nutrition of dairy cattle may be accomplished in a practical way with some assurance of good results.

Dr. E. B. Forbes of the Ohio Experiment Station, Wooster, Ohio, has studied this question of the feeding of minerals to dairy cattle more than any other one man. Dr. E. B. Meigs of the Dairy Division of the U. S. Department of Agriculture has also given attention to this question. Whatever is said in this article has been drawn mainly from these two sources of information.

For those who desire to look carefully into this question the following references are given:

The mineral nutrition of dairy cattle is covered by the Ohio Experiment Station bulletins Nos. 395-308-330-347, and in the monthly bulletin of the Ohio Experiment Station for July, 1920. Requests for these bulletins should be addressed to the Ohio Experiment Station, Wooster, Ohio. Dr. Meigs' paper on the mineral nutrition of dairy cows is in bulletin No. 945 of U. S. Department of Agriculture.

MINERALS NEEDED

The result of the study of investigators has shown us that aside from a liberal supply of common salt the necessity for mineral seems to be limited to calcium and phosphorus. Ordinary good rations seem to supply all other mineral elements with the exception of these two. A farmer ordinarily thinks of the question of calcium as lime. In this article we will stick to the terms of calcium and phosphorus. Anyone who thinks in terms of lime will know that when we speak of calcium, we mean lime.

A NEED FOR MINERAL MATTER

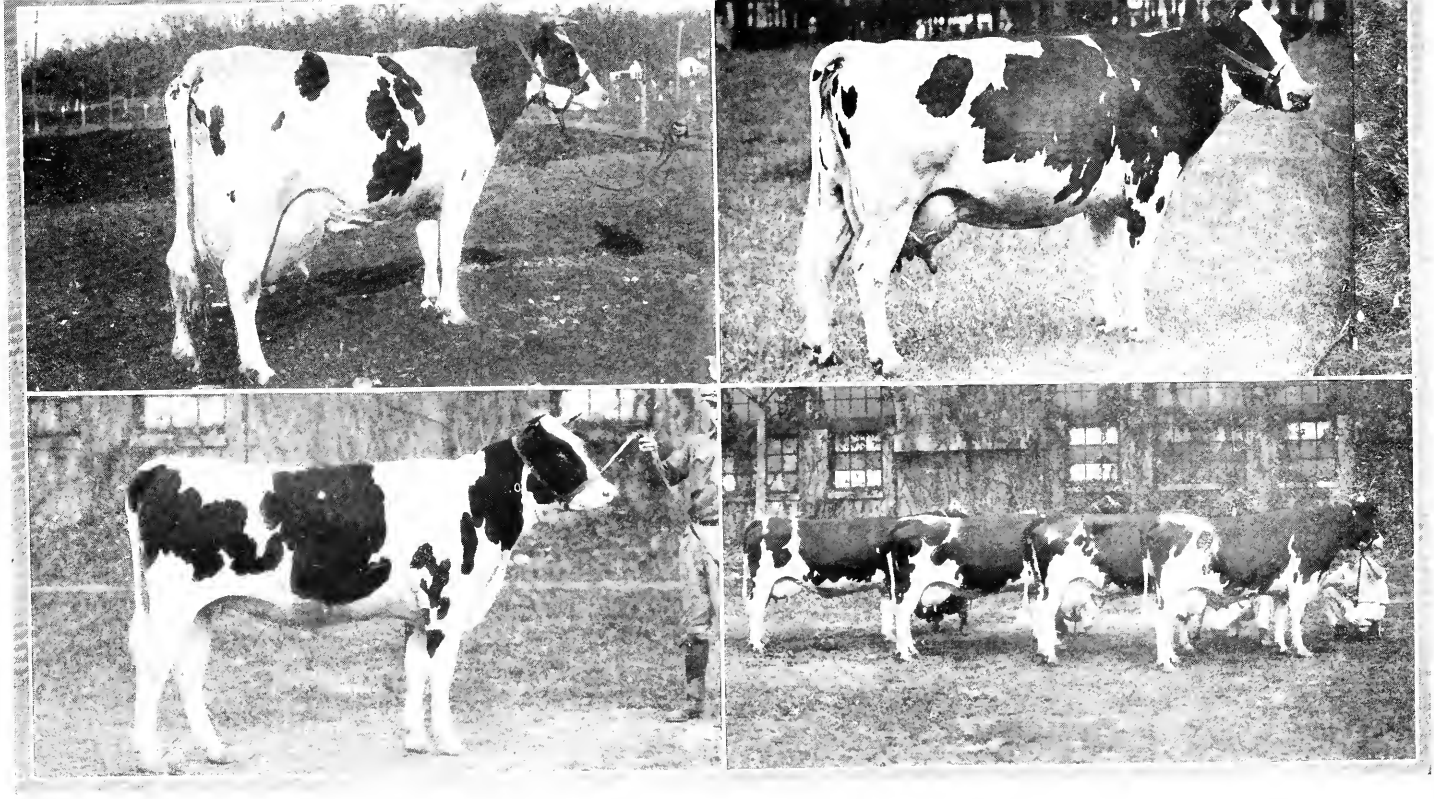
The need for mineral matter is perhaps best summarized by Dr. Forbes under the following three heads:

1. Rations abnormally poor in minerals. This may be due to an excessive proportion of grain in the ration; to forage grown upon impoverished or infertile soil; to the use of manufactory by-products which are poor in mineral nutrients; or to the substitution of foods poor in minerals for a natural food which is rich in the same, as in the use of some calf meals in place of the normal ration of milk.

2. The rapid growth of livestock which have been selected for early maturity.

3. The high mineral content of the product sought—eggs and milk, for instance, especially in unusually efficient production.

Cows need calcium to strengthen the bones and to grow the new bones in the young and to supply the large amount of calcium which is found in the milk. Careful experiments have shown that the dairy cow producing a good supply of milk will give out from her body into the milk, urine and feces, more calcium per day than she takes in in her food. There is only one place from which this extra calcium can come and that is her skeleton. Therefore, it is necessary for us to feed an abundance of calcium in rations throughout the year, in order that she may have a sufficient supply of calcium at all times in the feed to supply the amount put into



MAY ECHO SYLVIA

Champion milk producer for all periods from 7 to 120 days.

A PRIZE WINNING YEARLING

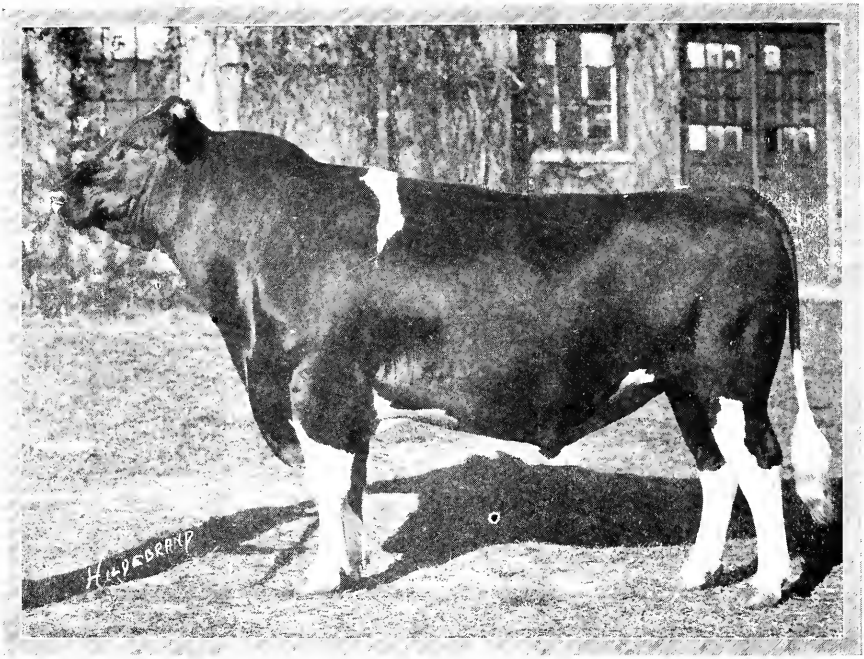
First prize junior yearling and junior champion female at the National Dairy Show, 1921.

DUCHESS SKYLARK ORMSBY

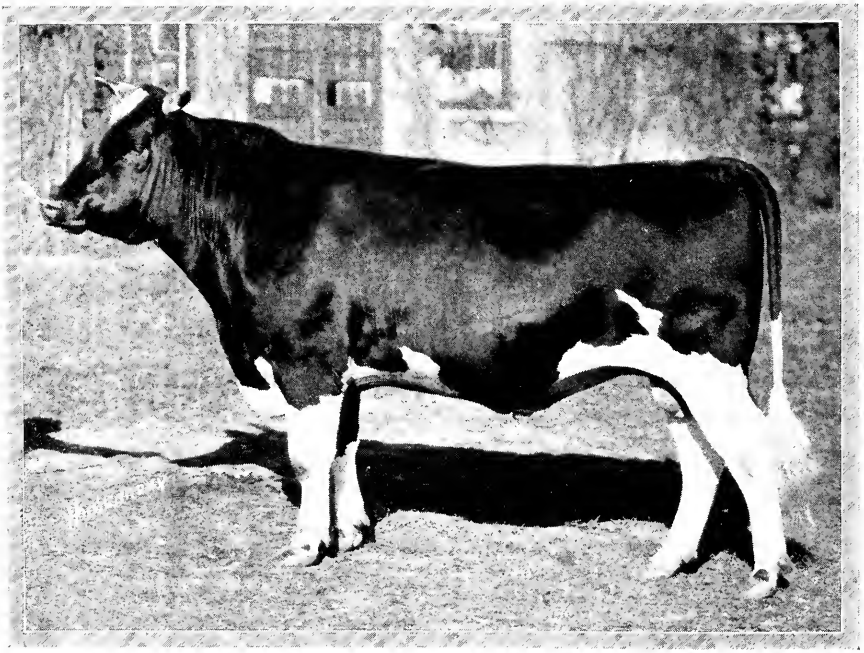
The first cow to produce over 1500 lbs. butter in a year.

A "GET OF SIRE" GROUP

First prize "Get of Sire" at the 1921 National. The grand champion cow stands at the end.



TRITOMIA PIETERTJE ORMSBY
First prize 3-year-old, senior and grand champion bull, National Dairy Show, 1921.



KING PONTIAC PARTHENEA CHAMPION
First prize senior yearling, and junior champion male, National Dairy Show, 1921.

the milk so far as her body is able to do this. If she is unable to assimilate enough calcium from the ration from day to day to put the necessary amount of calcium into the milk, then she must take it from her skeleton. This means that she must then build back into the skeleton, the necessary amount of calcium during the period of the year when she is giving little milk or during that period of the year when she is dry. Therefore, it seems doubly necessary to insure a plentiful supply of calcium in the ration when she is dry.

A large number of experiments have been made to study out the best way to supply this calcium. First and foremost comes the amount of calcium supplied by legumes. Alfalfa and clover carry more calcium than any other forms of roughage. All good roughages carry considerable calcium. Therefore the first and primary consideration in a proper ration for milk producing animals is a plentiful supply of good legume roughage.

In addition, the best way to supply this calcium seems to be in the form of steamed bone. There is a product put out by the United Chemical & Organic Products Company, 111 West Washington Street, Chicago, Illinois, called Special Steamed Bone, which has been used with success by Dr. Forbes. He has also used ordinary packers' steamed bone to good success.

To be very specific, it would seem to the writer that the best way to supply calcium in abundance to milch cows at all periods of the year would be to keep constantly before the cows a mixture of four parts of special steamed bone and one part of salt, or a mixture of four parts of ordinary packers' steamed bone and one part of salt. Packers' steamed bone can probably be secured from any one of the large packing houses.

MINERALS FOR CALVES

While calves are receiving an abundance of milk with roughage and grain there is probably no need for additional calcium. After they have been weaned and are getting no milk at all, it would be a good safety precaution to provide them with access at all times to either one of the mixtures recommended above.

In the experiments at the Ohio Experiment Station, reported in bulletin No. 347, both mature cows and calves seemed to prefer the four to one mixture of packers' steamed bone and salt to the four to one mixture of special steamed bone and salt. The ordinary packers' steamed bone would be cheaper and I can see no reason why the special steamed

bone would need to be used for these animals, unless it was found in any given herd that the ordinary packers' steamed bone was not palatable to the animals.

If the cattle would not eat enough of this mixture of steamed bone and salt to insure the consumption of an ounce of salt per day, then salt should be given to them in addition, unmixed.

FEEDING PHOSPHORUS

The experimental evidence on the necessity of the feeding of additional phosphorus to milk producing animals is not quite so definite or clear. Dr. Forbes' summary of the necessities for minerals by dairy cattle seems to indicate that sufficient phosphorus will be supplied in the ration if cattle have access at all times to this four to one mixture of steamed bone and salt. He makes the following statement:

"With some waste of phosphorus the whole supplementary mineral requirements may be served by calcium phosphate."

Calcium phosphate is provided by the steam bone mentioned above.

Dr. Meigs' work, as reported in bulletin No. 945 of the U. S. Department of Agriculture, shows that the feeding of additional phosphorus to cows during the dry period seems to have a beneficial effect upon their production in the succeeding lactation. Dr. Meigs recommends the feeding of phosphorus in the form of di-sodium phosphate (Na_2HPO_4). He recommends feeding this as 10 per cent. by weight of the grain mixture. Dr. Meigs' method of feeding phosphorus is to feed hay one day during the dry period and grain containing the sodium phosphate the next day. He calls this "alternate feeding with phosphorus." The reason for alternating the hay and grain is this. The calcium is contained to the largest extent in the roughage and the phosphorus is contained largely in the grain. According to Dr. Meigs, high calcium retention may be interfered with by a large amount of phosphorus in the ration, therefore, it seems to be better to feed the hay one day and grain the next with silage every day.

To my mind, the question is as yet somewhat unsettled as to the necessity of this additional phosphorus feeding if the steamed bone is fed regularly to the animals both during the lactation period and during the dry period. However sodium phosphate is not harmful to animals, neither is an excess of steamed bone harmful to them in any way. Consequently, I see no reason why the feeding of both the

steamed bone during the lactation period and the feeding of additional phosphorus during the dry period might not be practiced if one so desires.

The whole question of the proper supply of minerals is very well summed up in an extract from Ohio Bulletin No. 330.

Get your farm into a high state of fertility, and treat the soil, if necessary, so that it will grow legumes; then grow them, making as liberal use as is profitable of fertilizers containing calcium and phosphorus.

Consider with care your meadows and pastures; they are often neglected; if the soil is not rich, the mineral nutrients in pasture grass may be doubled by fertilization.

Build up the mineral reserves of your cattle by growing them largely on leguminous roughage or on pastures containing an abundance of legumes; and allow them exercise, as much as they incline to take. Muscular activity increases the avidity of bone cells for mineral salts.

Feed leguminous roughage during milk production; and give the cow a chance to refund mineral overdrafts by continuing the liberal feeding of leguminous roughage during the latter part of the period of lactation, and during the dry period, before the birth of the next calf.

Use as large a proportion of roughage in the ration as seems practical and profitable.

If you are short of leguminous roughage and must depend on corn fodder, straw, or hay made from grasses, or if on any other account there is reason to believe that your cows are not receiving proper bone food, give them bone flour. If they are already in good order there will be no marked change in condition but the feeding of bone flour will help to keep them at their best, and is good insurance.

In conclusion, I think we should see that the experimental evidence with regard to the whole question of mineral nutrition is not definitely decided and that it is very difficult to bring out definitely, any increased milk production through the feeding of additional minerals, but I would like to leave it with dairymen that I definitely suggest the feeding of some steamed bone flour at least during the dry period and for the best results, it seems that we would certainly have better and larger animals with the feeding of some steamed bone flour to our animals during their entire lives. I think there is less doubt of this than there is doubt of the question of feeding the additional phosphorus, in the feeding of sodium phosphate.

Feeding Dairy Cattle

In addition to its possible effect in size and production the feeding of a proper amount of mineral matter in the rations is bound to have a good effect on the breeding efficiency of dairy cattle. Observation tells us that with an abundance of mineral matter in the ration there is less sterility and other breeding troubles in the herd.

Part Two—Advanced Registry Feeding

XIII. Fitting a Cow for An Advanced Registry Test

THE best preparation for large advanced registry records is in proper breeding. The quickest way to get a herd properly bred is through the influence of the sire. Presumably this article is to be on the care and management and the feeding of cows that are to be tested for advanced registry, but the writer cannot refrain from introducing it with a few words on breeding. There is not much to be said on the feeding of animals about to be tested. The grain mixtures to be recommended are based on a few simple principles that can be put in a few words, and those words will be given a little further along.

A farmer who is going to test his animals regularly and keep it up, must school himself to the point where he will be willing to pay big money for the head of his herd. No volumes on fitting or on feeding are going to help him or make large records for him on animals that have not been well bred from the start, to give them the constitution and capacity to handle the feed necessary to produce the milk and fat.

Therefore study the breeding of your herd and the individuals, and study the breeding of those animals that are making the big records all the time. Then the sooner that you get the sire with the right kind of breeding and get the right kind of breeding in the cows to which he can be bred, the sooner the large records will come to your herd. We do not mean by this that feed and care are not important, for they are all important. But first of all let us get the cows and the bull and get to breeding right.

Then right on top of breeding comes experience. And the only way to get experience in testing is to test. A great many young breeders hesitate to begin testing because they think too much of the expense of it. It is expensive. But the plunge has to be taken sooner or later, and the sooner the better. The easiest time to put an A. R. O. record on a cow is when she is a heifer. Each year makes the requirement that much higher. Even if the records are low they are always worth more than they cost. It is so much better to say that this or that cow has an A. R. O. record than to

try to sell her or her calf when she has no record at all. If she is registered she is entitled to a record. And any farmer with any knowledge of feeding at all can at least cause his animals to make requirements. Many times he will be surprised with the results.

So begin, and begin now. With a beginning will come experience and interest. Then will come the great desire to have the best that is going and with those, with common sense, this means the beginning of real success in the dairy farming business.

Before beginning the actual feeding suggestions, the writer wishes to quote a little from a bulletin written by Professor T. L. Haecker, of Minnesota. In the handling of highly bred animals, and particularly of those we expect to test, kindness and even pampering will bring in good returns. Professor Haecker says this very well and we take the liberty to quote him:

"We know of many instances where the best of dairy cows were kept, and where good methods of feeding were practical and still results fell far short of what might reasonably be expected, simply because the animals did not receive that kindly treatment which is so essential to a cow giving much milk over a long period. The herd as a whole should always be moved slowly. Never hurry a cow or strike her or speak loudly or harshly. A gentle voice and a caressing touch are quite as potent as is digestible protein. If you so handle the cows that they are fond of you, you have learned one of the most important lessons that lead to profitable dairying. The most successful milk-producers are always in close touch with every cow in the herd. The milk-producer has to do with motherhood, in which affection always plays an important part. A cow's affection for the calf prompts the desire to give it milk; if you gain her affection she will desire to give you milk. If you have not been in the habit of caressing the cows, the time to inaugurate the practice is when they approach the time of calving, as it is at that particular time when they take kindly to grooming and to gentle rubbing of the udder."

In taking up suggestions for the feeding and management of animals that are tested we will take the heifers first. The preparation of a heifer for testing must begin when she is born. She must be grown well from the start. Much has been said about getting young stock too fat and thus destroying their dairy qualities and inducing them to lay on fat after calving rather than to turn all the feed into milk and butterfat.

Some careful experiments have been made by Professor Eckles on this point and the results seem to favor keeping the heifer somewhat fat for the best results in test when the time comes. Eckles fed one heifer on rich and abundant rations from birth to calving, while another was kept poor and thin. After calving the milk of the well-fed heifer tested over 4 per cent., while that of the poor heifer tested 3 per cent. After calving the fat heifer declined in weight and the percentage of fat in the milk remained about constant. The weight of the thin heifer remained about the same. After several weeks the weight of the fat heifer became constant and the percentage of fat in the milk declined somewhat. In the end the percentage of fat in the milk of both heifers was practically the same for the remainder of the lactation period. Observation by others has led to the same conclusion. Therefore it would seem to be wise to grow heifers well and fatten them somewhat before calving. There is no evidence to show that heifers treated in this way will be of poorer dairy temperament than heifers of the same breeding that have been grown on less grain and more roughage, heifers that have made equally good growth in frame but are not so fat at time of calving.

It may be well to let heifers that are to be tested after their first calf get well developed before breeding. This means to breed them to drop their first calves at thirty months. The strain of testing the first lactation and consequent high milk production may keep them from growing as well during this first lactation period. Then it is a good plan to milk them a full twelve months this first lactation period to form a habit of holding out well.

Good silage and legume hay is the foundation of the ration in the preparation period. The list of grains from which to choose is not long. Corn, oats, barley, wheat bran and oil meal are enough to choose from. A good mixture is:

30 pounds of corn meal or hominy
30 pounds of wheat bran
30 pounds of ground oats
10 pounds of oil meal

Another mixture liked by many is a modification of the above with more oil meal, i. e., using equal parts of hominy, wheat bran, ground oats and oil meal. One modifies it to suit himself.

Barley might be substituted for the corn meal and oats in part. This is simply a good growing ration and a fattening ration when fed in sufficient quantity. The feeder will feed enough in connection with the roughage to get the heifers

as fat as he thinks they should be. This will mean four to six pounds a day, practically from one year old to the time of calving, except on the very best of pasture.

The same mixture does very well for mature cows that are to be tested. Sometimes it is necessary to feed mature animals 10 to 12 pounds per day to get them in proper condition. It is the usual custom to rest cows that are to be tested a long period before. It has always seemed to the writer that a period longer than twelve weeks is not necessary, and perhaps it is detrimental to the best interests of the breed if the rest period is longer than eight to ten weeks.

XIV. Feeding for Advanced Registry Records

IN OFFERING suggestions in the feeding of individual cows which are being tested for advanced registry records, it is assumed that these animals have been rested for a period of eight to twelve weeks after having been carefully dried off. It is supposed that they have been well fed and cared for, that they have calved and cleaned all right and that they are in good flesh. Perhaps it is well to have them more than in good flesh, they should be fat for the best results.

While a large number of records have been made directly after calving in the first three weeks, on the average a cow does not strike her best gait until about three weeks after she has dropped her calf. She should be treated carefully from the start and watched, milked and cared for just as if she were doing her best at all times and if she shows a tendency to strike her gait early, then it is well to be ready for it and take all advantage of such a condition. Applications for a supervisor should be made with the proper authorities early enough to insure having one when one is needed. Getting a supervisor within two or three days of the time actually needed is almost entirely a question of making an application early enough, months before one really needs him. The experiment station or college authorities who send out the supervisors and authenticate the records are always very willing to cancel applications or to defer the time when a supervisor shall be sent if a reasonable notice is given by the breeder that he wishes his application cancelled or wishes his test deferred. Therefore to be on the safe side, send in your application about three months before the time you

will actually want the supervisor on the ground and then cancel or defer if necessary according to the way the cows show up. A little attention to this matter of early application will help the breeders to get supervisors when they want them and will help the authorities that authenticate the records to give better satisfaction to the breeder.

After a cow freshens and has straightened out she may be fed on good roughage and about four or five pounds per day of the grain mixture that was recommended for fitting, that is, a mixture of 30 pounds of wheat bran, 30 pounds of hominy feed, 30 pounds of ground oats and 10 pounds of oil meal or some modification of it. If everything goes all right the cow may be changed to the test ration three or four days after calving and the amount of grain gradually increased to the limit of her appetite. The increase should not be made faster than one pound per day except in some individual cases when the feeder knows his animal thoroughly well and knows that she can stand a more rapid increase than this.

THE TEST RATIONS: For roughage the first requisite seems to be alfalfa hay, or, if this is not obtainable, clover hay, corn silage with as much grain in it as possible and beets. The "Detroit Red" table beet seems to be preferred by most breeders. Mangels give nearly as good results. "Norbition Giant" is a good variety of red mangels, but is not as late a keeper as the yellow fleshed variety, "Golden Tankard." As to methods of feeding the roughage, most feeders slice the beets and feed the grain on them while the cow is being milked. It is usually best to milk four times in each twenty-four hours at intervals of six hours. This means from ten to fifteen pounds of sliced beets at a feed with a quarter portion of the grain mixture poured on the beets. If the cow does not have access to water whenever she wants it she should be watered before each milking. She can then be fed silage twice a day and hay twice a day, alternating the feed of these roughages between milkings. It is good practice to feed all the hay and silage she will eat, always seeing to it that her appetite is kept keen for all her food. In late years the practice of feeding silage has changed somewhat. Less and less silage is being used and more beet pulp and molasses are fed in its place. The silage is fed many times just to leave a nice clean acid taste in the cow's mouth.

THE MIXTURE OF CONCENTRATES: The writer suggests the following as a good mixture of concentrates:

500 pounds distillers' dried grains
300 pounds gluten feed
400 pounds wheat bran
400 pounds hominy feed
200 pounds oil meal
200 pounds cottonseed meal

This mixture of concentrates has given good satisfaction in a number of instances.

No exact directions can be given as to the amount of concentrates that shall be fed. This must be decided by the feeder. The size of the animal, her appetite, capacity, condition of flesh, are all characteristics which have an important bearing on the question of the amount to feed. Some cows are what is known as good feeders; others must be carefully watched. Sometimes it seems that the best way to handle a cow is to force her appetite to its limit until she is almost off feed. If she can be kept up to this limit it seems to have the effect of causing her to test high. If there is an indication that she may go off feed a good thing to do is to change her ration to the mixture of 30 pounds of wheat bran, 30 pounds of ground oats, 30 pounds of hominy and 10 pounds of oil meal, for a couple of feeds and reduce the amount even to two pounds. This sudden change of mixture and reduction of amount will cause her, many times, to come back on her feed at once with vigorous appetite. If a fluctuation in per cent. of butterfat is caused by this sudden change it is likely to be toward a higher plane. To those who have a quantity of good ground oats on hand, it might be well to put some ground oats in place of some of the bran and hominy feed.

The principles on which these suggestions for rations are based are simple. Alfalfa hay is good in itself and may be particularly useful in furnishing an abundant supply of lime. particularly in long time tests. The silage and beets are cooling and laxative. The mixture of concentrates suggested is properly put together to furnish a bulky mixture, plenty of easily digestible material, plenty of variety and an abundance of protein. Such large variety will probably insure a sufficient supply of the proper protein constituents and vitamines and things of this nature about which not very much is definitely known beyond the fact that the lack of an almost infinitely small amount may be the limiting factor in any given ration.

A study made by a student, Mr. W. L. Houck, under the

writer's direction about two years ago, may be of interest in this connection. Mr. Houck wrote to the ten breeders and feeders of the cows holding the highest yearly semi-official records in each of the four leading dairy breeds, Holstein-Friesian, Guernsey, Jersey and Ayrshire. He received answers to twenty-two letters out of the forty. He tabulated the results and found that the following feeds occurred in the rations the following number of times:

Alfalfa hay	12
Clover hay	None
Mixed hay	11
Beets or mangels	18
Corn silage	17
Pasture	11
Carrots	9

It is interesting to note that no one of the twenty-two breeders reported the use of clover hay; it was either mixed hay or alfalfa. Soiling crops were used in a few scattering cases. Pasture of course shows many times in these reports because these were reports on yearly record feeding. It is not likely that pasture would constitute any great part in the feeding for short time tests for seven or thirty days.

For the concentrates used, we have the following record:

	Times
Distillers' dried grains	14
Gluten feed	16
Wheat bran	22
Hominy feed	9
Oil meal	18
Cottonseed meal	13
Ground oats	16
Corn meal	7
Ground barley	5
Dried beet pulp	9
Unicorn dairy feed	1
Molasses	2

To the writer, these reports are very interesting and in a later paper, it is proposed to give the mixtures used by several of the feeders and breeders who have succeeded in making large records both in short time and in long time tests. It will be noticed that in the suggested mixture above those feeds are used that are most often found in the rations of the more successful feeders except that most of them, 16 out of 22, like to have ground oats in the mixture. The writer has already suggested that it might be better to use ground oats in place of a part of the wheat bran and hominy. Corn meal is nearly as often used as hominy. Hominy is likely to give better satisfaction. Dried beet pulp is used many times and is particularly useful when wet up in case one does not have mangels or beets. It can be used in place of corn silage.

but the times when purebred breeders find themselves without corn silage and alfalfa hay when testing should be so seldom as never to require notice.

OTHER SUGGESTIONS: Most breeders prefer to keep their animals in a cool, very well ventilated stable free from drafts. The cows should be blanketed. Very careful handling and quiet should prevail at all times. Occasionally an individual will be found who will respond to an extra amount of some particular feed, such as gluten feed, ground oats, oil meal, etc. In case this is known to the feeder, it goes without saying that she may receive regularly or from time to time, a pound or two of this particular feed, clear, on top of a little less amount of the regular test mixture that is being fed to other test cows. Attention to little details of comfort and individuality will be repaid many times in bigger results on the part of the cow being fed.

XV. Feeding Test Cows at Cornell University

AT CORNELL UNIVERSITY many creditable advanced registry tests have been made with several of them well above the 30-pound mark. Professor H. H. Wing, who has complete charge of the feeding and breeding of the Holstein-Friesian herd at Cornell University, can point to the development of this herd with pride, and the one cow that fully justifies our statement that Professor Wing knows how to breed and feed Holstein cows, is Glista Ernestine

In the feeding and development of this cow, Professor Wing has succeeded in getting her to make seven advanced registry records of better than 30 pounds. These records are showin in table as follows:

Time of Record	Milk	Fat	Butter
February, 1913	548.3 lbs.	24.410 lbs.	30.51 lbs.
September, 1915	625.7 lbs.	24.940 lbs.	31.05 lbs.
October, 1916	709.7 lbs.	26.660 lbs.	33.33 lbs.
February, 1918	823.3 lbs.	28.773 lbs.	35.96 lbs.
February, 1919	815.8 lbs.	27.742 lbs.	34.67 lbs.
May, 1920	666.5 lbs.	27.390 lbs.	34.23 lbs.
May, 1921	522.4 lbs.	25.153 lbs.	31.44 lbs.

No other cow so far as I know, has made seven 30-pound records in seven different lactations.

It is worth while to give in general, the methods used in feeding and testing under Professor Wing's direction. The best way to summarize the general methods and our ideas of good practice is to reprint the article by C. L. Allen which was published in the WORLD May 1, 1920. Mr. G. W.

Tailby, Jr., Mr. C. L. Allen and Mr. James Beiermeister have been the young men who have carried out Professor Wing's directions for longer periods of time than any others and in his article, Mr. Allen has given us a very careful statement of good practices. Mr. Allen's article follows:

"The making of large records of production is looked upon by many persons as an art of manipulating the animal which can be attained only by a very few men. This is true just in so far as it is true that it is an art for a mechanic to turn out a maximum amount of work by skillful manipulation of a delicate machine. On the other hand a man who is a careful observer, a good caretaker, and who has had sufficient practice, should be able to obtain good results. In order to make high records the most skillful feeder must have good cows with which to work and a good selection of superior feed for their consumption."

FITTING COWS FOR TEST

The universal practice in preparation for short time records and a quite general practice in preparation for long-time records is to fit the cows for the test. By fitting is meant the conditioning of the animal by rest and fattening so that she will be able to produce at a maximum by using her stored up energy for milk production. Another aim is to have the cow strong and healthy at calving time. In making short-time records it is customary to have the animal very fat. It is expected that fat cows will for a short time test higher than cows thin in flesh and thus make a higher butterfat record. Perhaps half of the animals fail to respond to this treatment, however. In any case fitting seems to aid production and high producers usually tend to become thin in flesh soon after they begin their lactation period. Thus it would seem that fitting aids the long-time record as well as the short-time record although probably to a lesser extent.

In fitting, the cows are usually dried off three or four months before calving and are fed a very liberal ration. The ration should consist of some good grain mixture together with pasture or hay and silage. It is quite common to feed a small amount of beet pulp also. Three to four pounds of dry beet pulp moistened with three to four times its weight of water would be a usual amount. The beet pulp helps to keep the cows in a laxative and generally good condition. Beets are just as valuable for this purpose but they are rarely fed because few men have a very large quantity of beets and they would rather feed them when the cows are on test.

The amount of grain mixture fed will vary with the size and condition of the animal. At this time, cows will eat from ten to twenty-four pounds each day. The grain mixture is usually light, palatable, and not very high in protein. Such a grain mixture which has been widely used with good results follows:

Fitting ration:
100 pounds wheat bran
100 pounds ground oats
100 pounds hominy
100 pounds linseed oilmeal (old process)

Many feeders have used cornmeal instead of the hominy in the ration with good results. The cornmeal, if used, should be fed with care or discarded entirely just before calving time.

One very important factor which is often overlooked not only in fitting but in the general care of animals, is the water supply. The cow should have free access at all times to all the good, clean water she will drink. If this is impossible she should be watered at least three or four times daily and should at no time be compelled to drink very cold water.

The question arises as to the danger of udder troubles, difficult parturition and milk fever due to the animal's being fat. If the cow is kept laxative but little fear need be entertained from the first two causes and rarely from the third. Cows can usually be kept in a laxative condition by the use of linseed oilmeal and succulent foods. It may be necessary in rare cases to use a purgative, especially if succulent foods are not available.

CARE AT CALVING TIME

A week or ten days before the cow is due to freshen, the grain ration should be reduced and she should be placed in dry, well ventilated quarters. If she is to occupy a box stall during the test she should be placed there at this time. Cows are usually kept in box stalls while making short-time records but this is not so commonly done for long-time records.

As the cow approaches calving time she should be carefully watched. It is particularly necessary at this time that she have plenty of water and be kept laxative. No fear need be entertained for swollen and caked udders so long as these conditions prevail and so long as the udder does not contain hard feverish spots.

If such hard feverish spots do occur they should be reduced by rubbing with warm water. Grease may be applied to keep the udder from irritation while it is being massaged. Patent preparations may be obtained for this

purpose and many of them are good but it should be remembered that the massage is the valuable part of the treatment and not the grease. Caked and swollen udders are not usually dangerous so long as all the quarters milk freely.

Milk fever is a disease which often affects the best cows after calving. Formerly there were many fatalities due to milk fever but the modern method of treatment, by distending the udder with air, has practically eliminated loss from this cause. It is commonly thought that milk fever may be avoided by leaving the udder distended with milk for two or three days after calving, when the danger from milk fever is usually over. It is best, however, to milk the cow a little at frequent intervals, two or three times daily, during this time in order to be sure that all the quarters are milking freely.

A common mistake is to try to feed the cow too much just after calving. She should be fed light laxative foods for three or four days and these in limited amounts. After three or four days, if she has a good appetite, the ration may be increased rather quickly to the amount she was receiving before calving.

FEEDING FOR SHORT-TIME RECORDS

The majority of short-time records are made in cool weather, approximately between the first of October and the first of May. There are several reasons for this. Farmers are usually not so busy with crops during this period and more time is spent with the cows. The most important factor however is the cool weather. An animal is able to eat much larger amounts of concentrated food during cool weather, and, therefore, will usually make a much higher record.

In making short-time records it is customary to start the cow on test just as soon as possible after calving. Cows form habits very readily and so it is best to start them at the beginning just they are to be handled during the test. During most short-time records cows are milked four times daily. It is best to begin this practice just as soon after calving as it is advisable to begin milking regularly. This is even more important with the feeding than it is with the milking. Experience has shown that it takes most cows nearly a week to become adjusted to a change from three times a day to four times a day for feeding and milking, and as a result the cows are placed at a great disadvantage.

Cows on short-time test are fed all they will eat. Most feeders give as much grain as possible without making the

animal sick. It is quite common to feed as much as twenty-five to thirty pounds of grain daily and much greater amounts are often fed. It is best, however, to proceed very carefully with all amounts in excess of twenty pounds each day. Cows that are fat from fitting will usually not eat so much grain as a cow that is thin in flesh. It is best to raise the grain ration not more than from one to two pounds daily and then wait a day or so to observe the results. It is useless to increase the amount of grain if the animals fails to respond with an increase in milk or butterfat production.

Warm days during the testing period cause considerable annoyance because the cows are not able to eat so much and are more likely to go off feed. To avoid such trouble one can often use a lighter ration instead of feeding a smaller amount. The mixture used for fitting is a good one for this purpose and the cow will generally appreciate the change. In practice it is often advisable to give the cows a little change in the grain mixture for one or two feedings, especially if the test runs for a couple of weeks or longer.

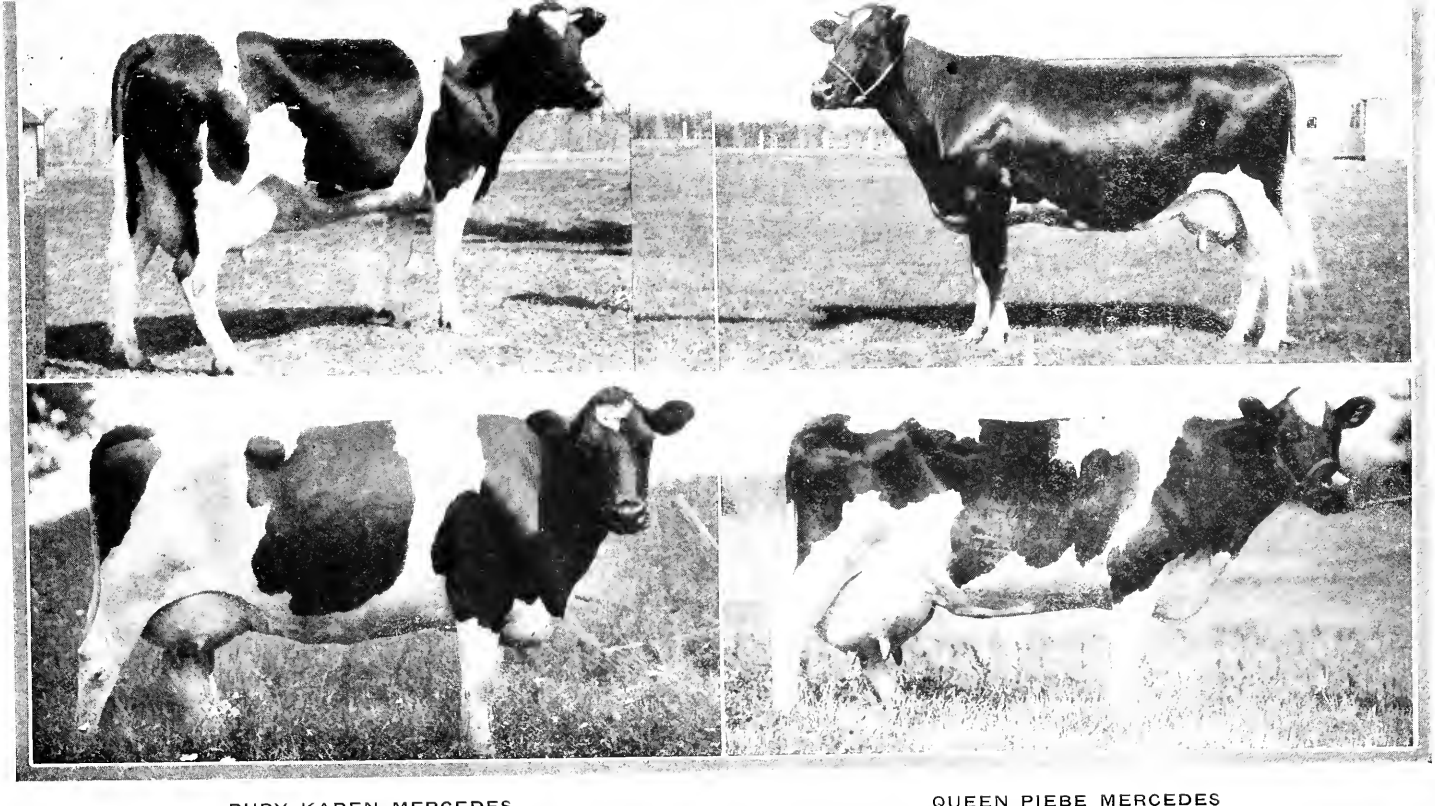
GRAIN MIXTURES FOR TESTING

The question of grain mixtures has always been much discussed and many feeders have been very exact as to the amounts of the different grains used. There are so many different mixtures used by successful feeders and they vary so widely that it would appear that the exact composition is not so important as many people suppose. From a study of a number of mixtures used by successful men it would seem that, if six or seven different grains were mixed together in equal proportions, the resulting mixture would be as good as any. About one-half the grain mixture should be derived from high-protein foods and the mixture should weigh about one pound to the quart. The grains most commonly found in grain mixtures are wheat bran, ground oats, linseed oilmeal (old process), cottonseed meal, hominy, gluten feed, and dried distillers' grains. Many feeders prefer to put salt in the grain mixture. If this is not done the cow should be fed salt regularly or have it continually before her.

The following mixtures have been used with good results:

Mixture 1

200 pounds distillers' dried grains
200 pounds wheat bran
100 pounds gluten feed
100 pounds ground oats
200 pounds hominy
100 pounds linseed oilmeal (old process)
12 pounds salt
12 pounds charcoal

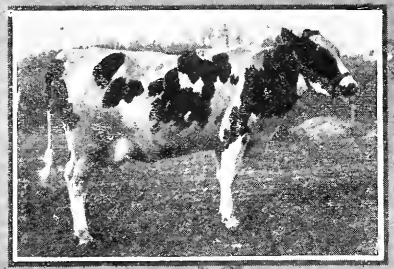


RUBY KAREN MERCEDES
A former Minnesota State champion. First prize A. R. O. cow at the National and the Cattle Congress, 1921.

KEYSTONE BEAUTY PLUM JOHANNA
World's champion senior 4-year-old for butter.

QUEEN PIEBE MERCEDES
World's champion 4-year-old for both milk and butter.

GLISTA ERNESTINE
Another view of the famous "seven-time" 30-lb. repeater.



NO. 1

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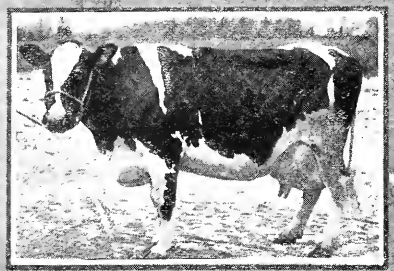

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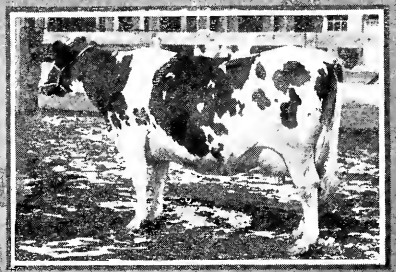


NO. 5

1. GLISTA CORA
3. GLISTA COREVA
2. GLISTA ERNESTIN
4. GLISTA EGLANTINE
5. GLISTA OMICRON

Five of the great 30-lb. sisters developed at Cornell University where Prof. Savage works out in a practical way his feeding theories.

Mixture 2
200 pounds distillers' dried grains
200 pounds wheat bran
125 pounds ground oats
125 pounds gluten feed
100 pounds cottonseed meal
80 pounds oilmeal (old process)
15 pounds salt

In the future, distillers' dried grains are likely to be very scarce and difficult to obtain. Such a deficiency may be overcome by increasing the wheat bran and gluten feed proportionally. Ground barley may also often be used to advantage in place of one-half the ground oats. No ration or grain mixture can be prescribed to meet all cases. It is desirable to cater to the likes and dislikes of the individual animal. This may call for wide departure from formulas ordinarily used.

In order to feed large amounts of grain with safety, it is necessary to feed roots of some sort. Beets or mangels are the roots chosen whenever it is possible to obtain them; the large mangels are perhaps as valuable as any. Beet pulp is used to supplement the beets at times, and in case beets or mangels cannot be obtained, it may be used entirely as a substitute. For best results the amount of beets fed seems to bear an almost constant proportion to the amount of grain. The proportion should be about three pounds of beets to one pound of grain. If beet pulp is used the proportion should be about one-half pound of dry beet pulp to one pound of grain. The dry beet pulp is moistened with three to four times its weight of water. Molasses is sometimes used to make the beet pulp more palatable. It is used in the proportion of about one-half pint to eight or ten pounds of dry beet pulp.

One of the most important factors in the ration of cows on test is the quality of roughage. It is commonly thought that poor roughage can be made up for by feeding more grain but this is not the case. The best results can be obtained only when the best quality of clover or alfalfa hay is fed. Alfalfa hay is preferable to any other.

Silage is usually fed rather sparingly to cows making short-time records unless some particular individual has a special craving for it. Succulence is usually provided for with beets or beet pulp and, if very much silage is fed, the animals are not able to eat nearly as much grain. If silage is fed, care should be exercised to feed only that which is good and sweet.

FEEDING FOR LONG-TIME RECORDS

In feeding for long-time records the methods are much the same as those practiced for the short-time records except that the cows are not forced quite so much, and are usually milked and fed not more than three times each day and often only twice. As was suggested for the short-time records, the cows should be fed a liberal amount of good grain mixture supplemented by good roughage. As in the case of the short-time record it pays to respect the likes and dislikes of the animal for certain kinds of food. The grain mixtures are much the same as those already mentioned.

The question of good roughage cannot be too strongly emphasized in feeding for long-time records. Roughage is the most important factor in maintaining a large milk flow, which can be increased in most cases by feeding better and more succulent roughage but which cannot be materially increased, as a rule, by increasing the grain ration. This is especially true when the cows have been milking three or four months. Because of the scarcity and the cost beets are not used extensively in feeding for long-time records but corn silage usually makes up the succulent part of the ration and it may be fed in rather large quantities with profit.

In changing from stable feeding to pasture in the spring it is well to keep in mind that the grass early in the season is not very nourishing, especially if the weather is very wet. The change should be gradual in any case and the cows should still have all the hay and silage they will eat for a week or more after being turned out to pasture.

As the season advances another problem confronts the feeder. The poor pastures of late July, August and September must be supplemented if the best results are to be obtained. Grain alone is not sufficient but some good roughage in the form of corn silage, green corn, or oats and peas should be used.

Good water is always such a necessary and often such a neglected requirement for the dairy cow that it seems worth while to mention it again. Whether in the pasture or stable, good water should be where the cow can have an abundant supply at all times without expending a great amount of energy to obtain it.

The best results can not be obtained without heeding the well-known fact that regularity of milking and feeding is an important factor affecting production. Not only should the milking and feeding be done regularly but the intervals between milkings should be as nearly uniform as possible.

Warm weather is a disturbing factor in long-time as well as in short-time records. It cannot be avoided in the long-time records and the best that can be done is to keep the cows as comfortable as possible. There should be plenty of shade where they can get out of the hot sun and away from flies. Anything that can be done to relieve the cows from flies will bring ample reward. There are many useful spray materials on the market that can be used to good advantage."

In addition to the above general statements of Mr. Allen, I wish to add the specific treatment of Glista Ernestine during the record that she made in the year 1920. We will begin with a summary of her feeding during the lactation period previous to her 1920 record.

In 1919, Glista Ernestine calved February 15. This last lactation ended the middle of January, 1920, and she calved again April 21, 1920. The rest period between was fourteen weeks. In this last lactation period Ernestine produced 22,854.6 pounds of milk containing 791.04 pounds of butterfat.

HER FEED

During this lactation period Ernestine ate the following amount of feed:

3860 pounds hay
8810 pounds silage
1425 pounds roots
3459 pounds dried beet pulp
7322 pounds grain

If we divide the amount of milk by the amount of grain we will find that she used her grain just as most cows do. She gave an average of 3.1 pounds of milk for each pound of grain that she ate. It might be said that the beet pulp should be considered as grain. I do not think it should in this case, if ever, because Glista Ernestine ate sparingly of silage and the silage was restricted all the way through, the beet pulp being soaked and used as succulence in its place. It seems to be better to restrict the amount of silage with test cows and use more roots and beet pulp in its place.

The great saving of feed in this case, as with all big producers is the saving of maintenance. The amount of feed necessary for maintenance is in proportion to live weight. Therefore, only one-half as much feed is necessary for the maintenance of the machinery when 20,000 pounds of milk is produced by one cow than if two cows have to be supported over a period of twelve months to produce 10,000 pounds of milk each.

FEEDING WHEN DRY

After Ernestine went dry the middle of January, 1920, she was fed about twenty pounds of grain per day until about two weeks before calving. For a part of the time this mixture was used:

30 pounds ground oats
30 pounds corn meal
30 pounds wheat bran
10 pounds oil meal

Then as the calving time approached and it was desired to put on what is called the "soft fat" and to get her ready for calving the mixture was changed to equal parts by weight of wheat bran, corn meal and oil meal. All during this dry period Ernestine got about fifteen pounds of hay per day and six to eight pounds of dried beet pulp soaked, but was fed no silage.

On April 5, 1920, her grain was cut down to ten pounds per day because her feeder wished to be very careful of her and not overdo it.

FEEDING AT CALVING TIME

Glista Ernestine calved last year April 21. For some unknown reason she had a two-day session of acute indigestion of which she gave no previous indication and from which she fully recovered. However, this short attack of indigestion meant very careful handling. About all the grain she got for several days was a little bran and oil meal. For several days the total amount of grain did not exceed five pounds per day and the light fitting mixture of oats, bran, corn meal and oil meal, the first one given above, was used. By April 30 she was gotten up to twelve pounds of grain per day, ten pounds of hay, and eight pounds of dried beet pulp. During these first days after calving she averaged about fifty to sixty pounds of milk per day.

FEEDING ON TEST

By May 1 Glista Ernestine seemed to have gotten back to her old form and was going well. She was continued on the light mixture, however, until May 5. For example, her regular daily ration from May 1 to May 5 was sixteen pounds of the light grain mixture, eight pounds of beet pulp, twenty pounds of beets and ten pounds of alfalfa hay.

Her feeder now thought it safe to begin feeding a little heavier so he changed May 6 to the regular test mixture. You will see that there had been no great hurry in getting Glista Ernestine up to her record pace. She has always been this way. Her best records have been made as a rule several weeks after calving, which shows that it is not necessary to

have a cow start right off with a bang. It is probably better in most cases to let them take their time and bring them up gradually.

THE TEST MIXTURE

The test mixture used for making records at Cornell University has been practically the same for several seasons. The exact mixture fed Glista Ernestine was:

100 pounds distillers' dried grains
100 pounds wheat bran
100 pounds hominy
50 pounds gluten feed
50 pounds oil meal
50 pounds ground oats
100 pounds cottonseed meal
10 pounds charcoal
6 pounds salt

It is difficult to get the distillers' dried grains nowadays, but in order to keep the ration that was wanted the College of Agriculture purchased two or three years ago several tons of distillers' dried grains before they went off the market and have kept them laid up just for advanced registry feeding. In case one cannot get distillers' dried grains, this mixture would probably be nearly as effective with the addition of twenty-five pounds of bran, fifty pounds of gluten feed and twenty-five pounds of oil meal in place of the one hundred pounds of distillers' dried grains.

When Ernestine was changed from the light fitting ration to the test ration her feed was cut down a little so that from May 6 to May 10 she was receiving daily twelve pounds of the test mixture, six pounds of dried beet pulp, twenty pounds of beets and ten pounds of clover hay. Her hay was changed from alfalfa to clover because the alfalfa hay seemed to be a little too strong for her. On May 10 the amount of test ration was increased to twenty pounds per day, the rest of the ration was made up of ten pounds of beet pulp, fifty pounds of beets, ten pounds of silage and ten pounds of alfalfa and clover hay. This has been the mixture fed ever since with the exception that beginning with May 20, sixty pounds per day of green rye was added to the ration.

To show just how the ration was fed daily, the ration was divided into four parts. Ernestine was milked at 5 and 11, being milked four times a day. She was fed at each milking five pounds of the test ration, two and one-half pounds of dried beet pulp soaked up and twelve and one-half pounds of beets. The beet pulp and the beets were put into a bushel bucket and the grain poured on top. Then at 5 a. m. and 5 p. m. she was given five pounds of silage, but she received no silage at the 11 o'clock milkings. As her feeder said, this

little bit of silage was given after the 5 o'clock milkings simply to leave a good taste in her mouth. The hay was carefully picked out so as to get first quality and a little bit put into her manger after she had finished her grain and silage, so that she could eat what she wanted between milkings. The green rye was fed in the same way.

This has given us detail enough—all that is necessary to say is that this sort of handling in feeding gradually increased the production and on May 24 the milk produced reached one hundred pounds a day. The average production for the record week, May 19 to May 26, was a little over ninety-five pounds per day. The fat production was 27.379 pounds of fat, or 34.224 pounds of butter. During this record week the total amount of grain fed was one hundred and forty pounds and the total amount of milk was 677.3 pounds. It will be noticed that Ernestine was producing 4.8 pounds of milk, testing 4.04 per cent butterfat, for each pound of grain fed. As we have said before, cows are ordinarily fed one pound of grain to three pounds of milk when the milk tests 4 per cent. This shows conclusively the answer to the question, whether it pays to feed cows well when dry. Ernestine was then in that record week using some of the feed that she received when dry.

This article has been written considerably in detail, because of the opportunity to write out exactly how a world's record cow is fed and handled.

Finally, we would call attention to this wonderful performance as indicating the tremendous value of a purebred sire, and call attention to the fact that after all, the one responsible factor in this whole question is the capacity that Ernestine and cows of her kind have for the utilization of feed above maintenance. We cannot fool with little cows of small production and small capacity in any breed, because too much feed is eaten up in merely running a lot of useless machinery.

XVI. The Rations Fed Some Famous Cows

THIS series of articles has been written largely for the young breeder and feeder who is just starting in the business. It is the wish of the writer to be of service to as many as possible on the question of feeding; to bring to many the experience of others on feeding questions. This article then will give, as far as we can, the actual feed mixtures used, the amount fed, and other things of that nature

with some of the high record cows of the Holstein-Friesian breed. To get the data for the article a letter was sent to the owners or feeders of the highest seven-day record cows and the highest semi-official record cows. The answers to this letter have been very satisfactory, and the writer wishes to thank these men personally who have co-operated in the preparation of this article.

Young feeders and breeders like to know what the most successful feeders in the breed have used in getting the wonderful records that are now being made. It is a great source of satisfaction that the successful feeders and owners are so ready to tell us just the manner in which it has been accomplished.

THE FEEDS USED

First of all it seems best to list all the feeds used in the feeding of the cows here considered with the number of times each is found among the rations. This will tell us the most popular feeds.

Concentrates:

Ground oats	6 times
Wheat bran	6 "
Wheat middlings	1 "
Gluten feed	4 "
Gluten meal	1 "
Distillers' dried grains	6 "
Cottonseed meal	3 "
White Cross feed	1 "
Linseed oil meal	3 "
Brewers' dried grains	2 "
Hominy	3 "
Malt sprouts	1 "
Ground barley	1 "
Dried beet pulp	1 "
Molasses	1 "

Below are given the roughages used in the six rations considered:

Roughages:

Corn silage	5 times
Alfalfa hay	5 "
Clover hay	1 "
Roots	5 "
Green crops	2 "
Pasture	2 "
Timothy hay	1 "

It is noted that the most important concentrates used for this purpose are ground oats, wheat bran, distillers' grains, gluten feed, oil meal, hominy and cottonseed meal. Alfalfa hay, corn silage and beets are the most important roughages. The rations shown here and given in previous articles should teach convincingly that it is unnecessary to go outside this list for feeds and that nothing is gained by doing so. It is

time that the idea that large records are being made with secret formulae should be driven out of the heads of our breeders. It is foolish to think that secret formulae and drugs are necessary to produce these records. Our breeders must get to work and learn the arts of breeding and skillful feeding and forget all this foolishness about drugs and secret formulae. If you have the cow that is capable of doing it through her inheritance and if you have the skill to feed her and care for her, the above list of feeds is all that is necessary.

FEEDING FOR SHORT-TIME TESTS

We have received replies to our letter from several of the feeders of cows making creditable short time records. From these letters I have selected the statements of feeding of Tietje Queen Kol 2nd, Glen Alex Queen De Kol, Glen Alex Queen De Kol 3rd, and Bess Johanna Ormsby. A statement of the feeding of these cows will give us a good idea of the general practices in the feeding of high record cows.

Tietje Queen De Kol 2nd

The best thing to do in connection with this cow is to quote the following from a letter from Mr. A. C. Howe:

"Tietje Queen De Kol 2nd was born May 11, 1913, and freshened at the age of 2 years six months and twenty-three days making 16.793 pounds butter and 393.8 pounds milk.

"At three years, eight months and five days she made 31,068 pounds butter and 494.6 pounds milk after giving birth to twin calves, both being as large as the usual calf. At four years, ten months and twenty-six days she did even better making the very creditable showing of 43.29 pounds butter and 639.3 pounds milk.

"While being fitted she had all the alfalfa hay she wanted and some beet pulp moistened with molasses together with the following fitting ration:

200 pounds bran
100 pounds cottonseed
200 pounds ground oats
50 pounds ajax
150 pounds hominy
100 pounds oil meal

"While on test this cow had ensilage morning and night and beets at noon and midnight, some alfalfa hay and the following milking ration:

50 pounds ajax
20 pounds oil meal
50 pounds bran
4 pounds salt
30 pounds ground oats
2 pounds charcoal
30 pounds gluten

"This cow is an exceptionally large and vigorous animal and never seemed to have enough either when on test or at any time in her life being always up and looking anxiously at the feed door whenever any one started feeding. She never went off feed and we have always thought her a fine candidate for a long time test but up to the present time we have never been in a position to give her an opportunity. Another thing which might be well to mention is that we have the individual drinking cups and this cow had access to all the spring water she wanted and whenever she wanted it except directly following calving."

Glen Alex Queen De Kol

Glen Alex Queen De Kol also made her best record of 42.35 pounds of butter at Mr. A. C. Howe's farm. She is at present owned at Hollywood Farm, Hollywood, Washington. Mr. H. C. Stimson sends me this account of her feeding which he received from Mr. Howe:

"Glen Alex Queen De Kol was born April 9th, 1914. At 2 years, 11 months, 20 days, she made the following record having calved (second calf) March 29, 1917: Milk, 603.8; butter, 42.36; best day's milk 91.7. Previous to this test she was fed 200 pounds bran, 200 pounds ground oats, 150 pounds hominy, 100 pounds cottonseed meal, 50 pounds Ajax, 100 pounds oil meal, beet pulp soaked in water and molasses, 5 to 10 pounds daily, about 20 to 30 pounds silage and 10 to 15 pounds alfalfa. Two weeks before freshening the Ajax and cottonseed were omitted. After freshening, she was fed 50 pounds Ajax, 50 pounds bran, 30 pounds ground oats, 30 pounds gluten, 20 pounds oil meal, 4 pounds salt, 2 pounds charcoal. Cottonseed meal was added from time to time, 10 to 15 pounds beet pulp per day, 20 to 40 pounds silage, and 10 to 20 pounds alfalfa hay.

"She has made three 30-pound records since we purchased her. She will weigh above 1800 pounds and if confined will develop a tremendous appetite. We have fed her over 40 pounds of grain without the least apparent harm. When released from small quarters this appetite or craving for grain disappears considerably. In all other respects she is absolutely normal, and is an extremely profitable year round producer."

Glen Alex Queen De Kol, 3rd

The best way to give us the data on the feeding of some of the best cows at Avondale Farm is to quote directly the letter of Mr. H. Flynn. Mr. Flynn's letter follows:

"Yours of recent date to Mr. Hardy has been handed to me for reply regarding the feeding and management of the cows, 'Glen Alex Queen De Kol 3rd,' and as Mr. Hardy in his reply to you, mentioned our other cow or rather heifer, namely, 'Lady Waldorf Sylvia,' this heifer having the honor of holding the world's record for 305 days after having made over 28 pounds butter in 7 days at 2 years, 7 months. Name and number of first heifer is Glen Alex Queen De Kol 3rd, number 382579, born March 23, 1917, and the second heifer is Lady Waldorf Sylvia, number 399694, born March 23, 1917. Glen Alex Queen De Kol 3rd freshened December 2, 1919. and at that time started in and made the world's records for seven and thirty days for heifer with first calf. Lady Waldorf Sylvia heifer freshened November 20, 1919, and started in making her great record. Now both of these heifers were born the same day and both weighed almost alike at time of freshening. They both weighed a little over 1650 pounds. Both were fitted with same ration and both fed same ration while being tested. Fitting ration was composed of bran, 200 pounds; hominy, 100 pounds; ground oats, 100 pounds;, and oil meal, 100 pounds. Both heifers ran on grass until in October but were brought in daily for about three months, and fed the above ration together with whatever silage they would eat which was not very large on account of eating a certain amount of grass. About three weeks before freshening each got at least one feed of roots a day. When grass was done they had all the clover hay they wished to clean up. Both freshened in fine condition and started in making their records. The first two days after freshening they both had a light ration of bran and oil meal. Third day starting in on test ration, being fed 8 pounds a day to start on, increasing gradually. Test ration composed of distillers' grains 336 pounds, bran 207 pounds, ground oats 156 pounds, gluten feed 142 pounds, hominy 114 pounds, oil meal 50 pounds, salt 10 pounds, charcoal 10 pounds. This ration was fed four times daily, roots also four times, silage three times, omitting the midnight feed. This was good corn silage, of course, also fed good alfalfa hay twice daily, morning and evening. This I think constitutes the feed fed to produce both world's records. You mention in your letter about 'Walnutcrest Rag Apple Buttercup.' The record this heifer made at two years old of course was not a world's record although she won first prize association money a year ago making over 28 pounds. Her number is 428001 and born January 28, 1918, and freshened March 16, 1920, and was

fitted with same ration as the other heifers. Also fed same test ration only in a much smaller quantity. The roughage also was made up of same material. Hope this will help you out on your book of 'Feeding Dairy Cattle.'"

Bess Johanna Ormsby

Mr. J. R. Danks, superintendent of cattle department at the Winterthur Farms has written me statement of the feeding of Bess Johanna Ormsby, when she made her last 7-day record, from February 22 to March 1, 1921. Mr. Dank's letter follows:

"The record was: 30.536 pounds of butterfat; 650.4 pounds of milk.

"Her daily ration was as follows:

"Six pounds ration No. 7, 6 pounds ration No. 8, 2 pounds ground oats, 1½ pounds oil meal, 16 pounds silage, 25 pounds alfalfa hay, 5 pounds beet pulp, 26 pounds mangels.

"Ration No. 7 is composed of: 300 pounds bran, 300 pounds oats, 100 pounds hominy, 100 pounds, oil meal, 100 pounds distillers, 50 pounds gluten.

"Ration No. 8 is composed of: 200 pounds ground oats, 200 pounds bran, 200 pounds distillers, 200 pounds oil meal, 50 pounds cottonseed. This cow was fed one quarter of her daily ration at 4:30 a. m., and milked while she was eating. This was done again at 10:30 a. m., 4:30 p. m., and 10:30 p. m.

"At 7:30 a. m. she was turned in the paddock for exercise for about one hour. During the balance of the time she was kept in a good roomy box stall equipped with watering device. She was given about all the grain she would eat with relish.

"This cow has, of course, made two previous 7-day records but, as they were made quite some time ago, I am not sure about the feed and management, therefore, I am giving you her latest record. As I understand it, you are not interested in her semi-official record.

"The amount of grain, also the roughage, varied slightly from day to day but the various kinds of grain fed remained the same throughout the test."

Many other letters could be quoted on the subject of feeding cows for 7-day tests, but these letters that have been given will give us what we want very fully, and it seems unnecessary to quote more.

FEEDING COWS IN THE YEARLY DIVISION

It is with much pleasure that I am able to lead off the discussion of feeding cows for the yearly advanced registry

records by quoting the statements with reference to the feeding of Bella Pontiac. This statement of her feeding appeared first in the WORLD for June 25, 1921, when it was written up by Mr. M. S. Prescott. For the sake of making the book complete it is worth while to reprint a part of it here.

"Completing her 4-year-old record on March 24, she freshened again June 19, having been dry about six weeks. She started out very easily on a light feed of wheat bran and oil meal with green alfalfa for roughage. About the first of July green mangels with the tops on were given her fresh from the field to the extent of about a bushel and a half a day and she has shown great fondness for these roots throughout the test. As soon as she settled down to work she was put on to a ration consisting of: 2 pounds bran, 6 pounds oil cake, 1 pound gluten, 2 pounds crushed oats with a maximum of 12 pounds cottonseed meal. Of this ration she ate from thirty to thirty-three pounds a day up to as high as 37 pounds a day at the highest. With this grain ration she took from 60 to 70 pounds of roots, 25 pounds silage and all of the alfalfa hay she wanted. About the fifth of April the supply of silage was exhausted and quite a radical change was made in the whole ration. The roots were increased to about 150 pounds a day, the cottonseed meal was cut out entirely as she appeared to be getting tired of it and and the oil cake reduced to half so that the ration she finished her year on is just a mixture of 2 pounds bran, 2 pounds crushed oats, 1 pound oil cake, 1 pound cream of wheat. Each feeding is weighed out separately with one-quarter of a pound of salt and a handful of charcoal in each feeding. The grain is given before milking and after that is cleaned up the roots are fed and the alfalfa hay is placed in the manger and two pounds more crushed oats is given on the roots making a total of eight pounds of grain per feeding, or 32 pounds a day. A tub of drinking water stands in one corner of the stall where it is accessible at all times. This is washed out and fresh water put in every day. She is having no green feed whatever this spring or summer and the changes in her ration have been made in an effort to give her what she particularly likes the best. Throughout the year she has occupied a light roomy box stall and has been out only to be led occasionally for exercise. This has not been given regularly as Mr. Barron in addition to looking after this cow and the rest of the herd has had all the work of a seventy-acre farm to attend to himself. Practically all

of the care of the new champion must be credited to Mr. Barron, although during the Canadian National Sale where he sold a few head, Mrs. Barron looked after the milking. Mr. Wilson, the supervisor, also milked her about a week when Mr. Barron was ill. We mention these facts here as added testimony to the honesty of the record. It was impossible to get a tester at the beginning of her present year's work but she milked up to nearly 100 pounds and seven months after calving made a seven-day record of 33.02 pounds of butter and the week preceding our visit which was the fifty-first week of her year she made under strictly official test 28.05 pounds butter and 487.5 pounds milk showing an average test of 4.6 per cent fat. In the thirty days from May 14 to June 12 which figured the thirty days preceding the date of our visit she made 106.03 pounds butter which indicates the evenness of her performance throughout the year. She has not been bred, but comes in heat regularly and appears perfectly normal in every respect.

"There is a wonderful object lesson in this story of Tom Barron and Bella Pontiac for it shows how the highest success with Holsteins can be won without large capital and with modest buildings, by applying intelligent and painstaking effort to the care of the right kind of a Holstein cow. The barn in which the new champion spent her year would hardly measure up to the average dairy barn in Canada or the dairy sections of the United States. The man who milked and fed her and looked after her wants also looked after the rest of the herd and did the farm work besides, but let nothing stand in the way of giving Bella Pontiac the best chance he knew how. When it was apparent that there was chance for her to at least break the Canadian record he sold the most of his milking cows including the 36-pound Dora Fayne Posch that was the sensation of the Canadian National Sale last spring, reducing his milking herd to three head.

"He studied his cow so closely that although she has eaten about 30 pounds of grain a day the greater part of the year she has never been off feed, although coming close to it once or twice, and several radical changes in the composition of her grain rations were necessary. A less close observer would have continued the gluten which she never liked and the cottonseed meal which she tired of, when about nine or ten months along with her record. As a reward for his efforts, Mr. Barron has made his original investment increase one hundred fold or more; he has a World's Champion cow over all breeds and for the period most keenly contested for,

and he has in addition two beautiful daughters of that World's Champion, one a yearling and the other just past two years of age.

In the story lies most effective ammunition for Holstein extension work, because who of us in the business upon reading the story of Tom Barron and Bella Pontiac will not go on with our work with just a little more zest and give our own good cows just a little better chance to show what they will do?"

The record of the feeding of Bella Pontiac is particularly interesting because of the unusual amount of high protein feeds that were fed in the first part of the year's work. This goes to show very conclusively that there must be very little in the idea of secret formulae and that after all it is the capacity of the cow that determines the record and that a cow has tremendous capacity for adapting herself to the ration as she may get, provided she gets good care and enough feed from which to manufaceure the milk.

Duchess Skylark Ormsby

Duchess Skylark Ormsby made her great record some time ago but she still stands second in the list, therefore, it is well to say something about her feeding. Mr. John B. Irwin has written fully and carefully on this point and I take pleasure in quoting his letter:

"Your favor of July 11th regarding information concerning the grain mixture for Duchess Skylark Ormsby is at hand, and I may state that she was quite remarkable in her food consumption in that she was not affected seriously by change of feed and the different ingredients of her ration were changed in amount quite frequently so as to adapt them to her appetite and the condition of the weather. Possibly if I give you the amount of feed she consumed in three different months it will give you a pretty good line on the feeds we used. For instance she calved early in November. She consumed the following feed in the month of:

December	May	September
lbs.	lbs.	lbs.
124 bran	125 bran	120 bran
124 ground oats	120 ground oats	120 ground oats
93 continental gluten	100 continental gluten	90 continental gluten
124 brewers' dried grain	125 brewers' grains	125 brewers' grains
77 oil meal	90 oil meal	75 oil meal
75 hominy	45 hominy	60 hominy
868 silage	900 silage	3000 silage, green oats and peas
455 alfalfa	475 alfalfa	450 alfalfa
930 roots	950 roots	1000 roots

She was fed and milked four times per day throughout the year, was kept in a good sized box stall, led out nearly every day for exercise but was not in pasture at all since we had a very hot summer and we preferred to keep track of her feed and keep her away from the flies as much as possible in the barn. She was bred in July and once after that during the test but failed to get with calf from the first service. She dropped a splendid matured calf just shortly before her death but we were unfortunate in losing the calf."

Miss Valley Mead De Kol and Miss Aaggie Acme Burke

These two young cows have been fed out by A. W. Morris & Sons. Mr. F. L. Morris has written the following concise letter which gives us a very definite idea of how they handle these wonderful cows in California. Again this letter shows that the feeding and handling is not complicated, provided you have the correct type of cows and have good men to handle them.

"Miss Valley Mead De Kol and Miss Aaggie Acme Burke were kept in box stalls at night and during the stormy winter weather, however, they were outside part of every day, and when the weather permitted, ran at pasture, possibly during nine months of the year. After the morning milking they were allowed to pasture for four hours, and also for an equal time in the afternoon. The pasture consisted of alfalfa and our native grasses which are green during three or four months in the spring.

"Our grain mixture consists of ground barley, oats and bran in about equal parts. This is supplemented by linseed oil meal, cocoanut meal, cottonseed meal and soy bean meal, varying in amounts according to the requirements of the different animals. We feed at all times either corn ensilage, dried beet pulp or fresh beets when in season. The cows are given what alfalfa hay they will clean up at all times.

"This is about all that can be said in connection with the handling of our cows in yearly test, and we trust that it may be of some use in the article you are preparing."

Rose De Kol Wayne Butter Boy

The record of this cow is given because it shows how high test cows are handled in Iowa, another section of the country and also because this cow has had a good record and is famous not alone for her record as a junior 2-year-old, but also for her 3-year-old and 4-year-old records which are world's records.

Mr. R. A. Arnold writes as follows concerning her feed and management:

"Rose De Kol Wayne Butter Boy is creating quite a name for herself as a yearly producer and is now on test her fourth year as a 5-year-old and looks like she will make 1200 pounds of butter. She has been milked and fed four times per day from the time she first freshened as a junior 2-year-old and has had but very little rest between her lactation periods. This cow has had a small amount of grass and soiling crops in lots near the test barn. We always make a practice of letting them out part of the time for exercise, and a little green grass. She has also carried a calf quite a long time with each record she has made, and until this last lactation period she has been very easy to get with calf.

"Our main yearly ration: three parts ground oats, three parts bran, two parts ground corn and one part oil meal. Rose De Kol has always had more oil meal than the rest of our cows. These rations are changed from time to time somewhat to add variety and a change. Different cows are fed different amounts of the grain. We have always for Rose De Kol quite a lot of molasses and while she has never had beets she has always had liberal ration of beet pulp. She has always consumed large quantities of alfalfa hay. During most of the month she has had quite a lot of ensilage.

"If you will study her production you will see that her 2-year-old record is the second highest ever made for age. Her 3-year-old, 10-months' record, is a World's record for butter for age, and her 4-year-old, 10 months' record is also a World's record for butter for age. The total of her three lactation periods for butter and for milk under full age are larger than any other Holstein cow and they are both world's records. The butter record being excelled by a Jersey who was run three full years.

"We expect to continue her on test as long as she lives, and if she is fortunate in keeping up her good work, she ought to make a great life-time record."

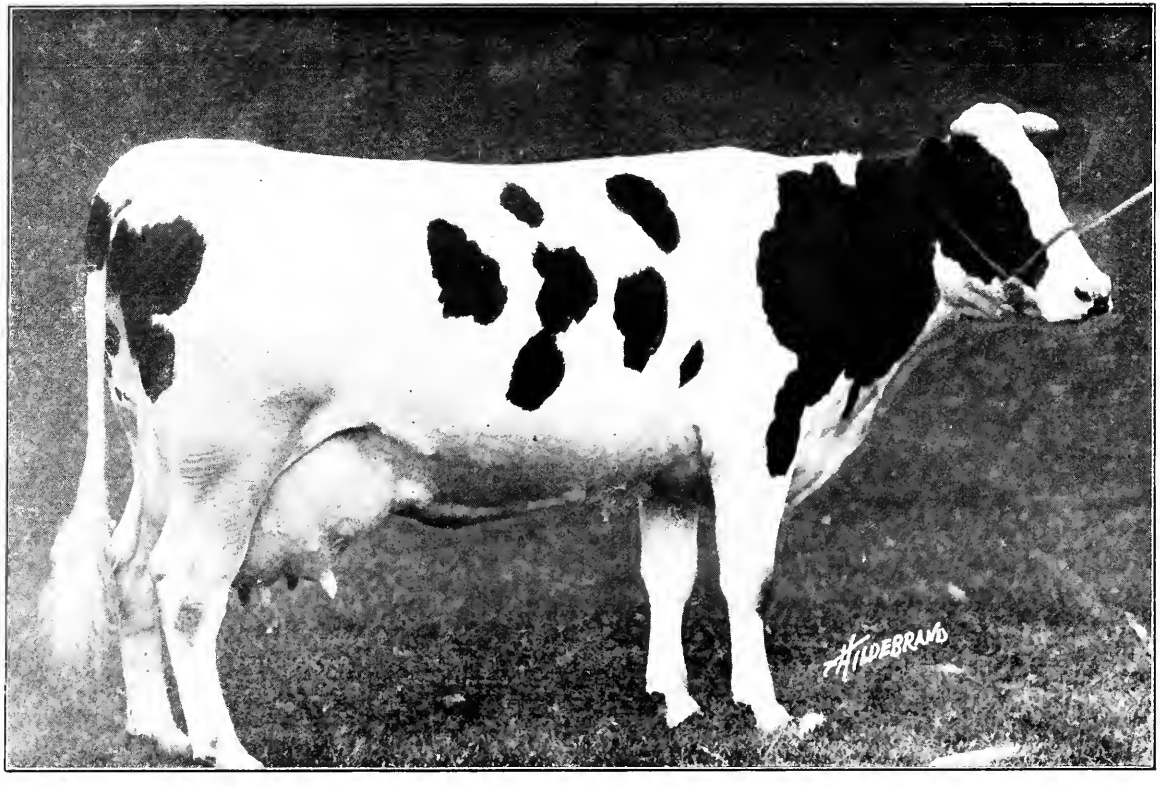
Jewel Pontiac Segis, Beauty Girl Pontiac Segis, and Beauty Beets Walker Segis

These cows were fed the following grain mixture:

100 pounds barley
100 pounds hominy
100 pounds bran
100 pounds brewers' grains
50 pounds oil meal
50 pounds Schumacher feed

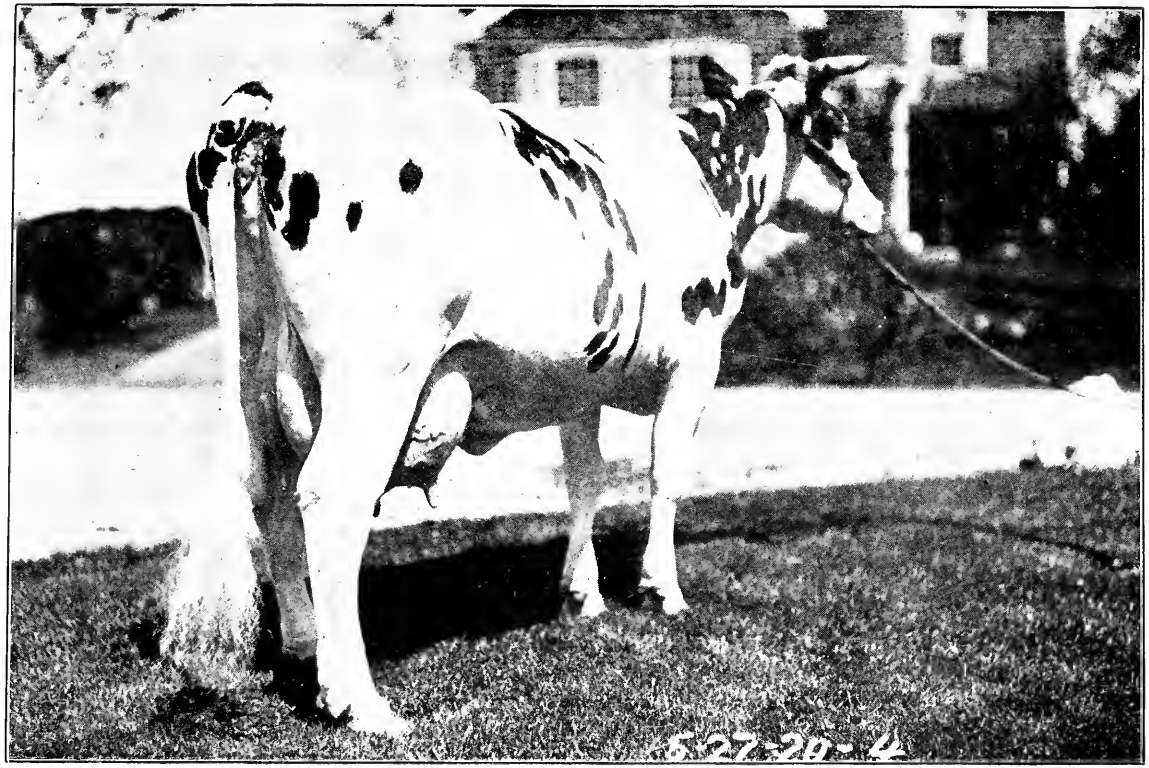
In a letter giving the above mixture used for feeding these cows, Mr. Hackney writes as follows:

"I do not allow crowding of feed in any way. They live just as normally as though they were not on test. I keep



BEAUTY BEETS WALKER SEGIS

World's champion senior 2-year-old for milk production; world's champion also for first three lactation periods. Photo in 4-year-old form.



DUTCHLAND PIETERTJE VALE
A New England Champion representing the fourth generation of New England and World's Champions.

them as closely as possible to the lines intended by nature. In my herd of over 250 head, we have had only two non-breeders in the past five years, and those were not of my own breeding. I want to say also something that you will perhaps consider even more startling, viz: That all of the daughters of Count, that have made such phenomenal records, more than the daughters of any other sire of any breed, are breeders—there is not a non-breeder among them. We are very proud of this record at rden Farms." This quotation shows clearly the kind of Holstein breeding and feeding that Mr. Hackney stands for.

Segis Pietertje Prospect

Carnation Stock Farms have made some good records. Probably the best way to end up this statement of the feeding of cows for long-time records is to print the statement of Mr. Carl Gockerell, on the care and feeding of Segis Pietertje Prospect. No other has been able to produce as much milk in one year as this cow. Mr. Gockerell's statement follows:

"Those of us who have known Segis Pietertje Prospect for some time cannot help but marvel at her remarkable development during her hard year's work. In every way she is a bigger, better cow, a more efficient machine, and at the end of her year she is in perfect physical condition in every way. We always knew the cow to be a consistent producer, but it took a great deal of careful and persistent study to bring out all that was in her. She was dry a little over two months, preparatory to her test. During that time she was fitted on a ration consisting of equal parts of ground oats, bran, hominy and oil meal and some salt and charcoal. She received a small amount of beet pulp and a few beets. At freshening time she was just in good condition. She freshened nicely and had a slight attack of milk fever the day after freshening, but rallied quickly. She was started on a semi-official test the morning of December 20th. At that time, appreciating the fact that in order to be a good long distance runner, a man must go easy at the start, the cow was fed very conservatively—receiving 17 pounds of grain daily. She came on nicely, and on her ninth day on test milked 118.6 pounds. As the table below shows, her feed was then gradually increased, until the month of March. During that month she produced 3716 pounds of milk in 31 days. However, it was noticed that this pace was a little too heavy; accordingly her feed was decreased. The following table shows very clearly her feeding schedule.

"Several very interesting features may be noted here. Probably the most important is the immense amount of roughage she consumed at all times. Invariably when any drop was noted in her production it could be traced to the hay. We tried to find first cutting alfalfa that had been through a sweat and had the leaves nicely attached. But during the months of July, August and part of September we were unable to secure this. She also ate considerable green feed; starting in March with Italian rye grass then oats and peas and in the fall, sweet corn. We ran out of this in October. We tried feeding her silage several times, but were not successful. Believe this was due to some peculiarity of the cow. She is a cow that loves freedom and lots of fresh air. During her fitting and up to July of her test period, she had access at all times to an open runway and spent the greater part of her time out there, rain or shine. In July we made the mistake of moving her into a screen stall where she could not get exercise, and a difference was noticed at once. She was kept there ninety days, and was then returned to her old quarters, very much to her happiness.

"Segis Pietertje Prospect weighs 1650 pounds—is in fine physical condition at the end of her test, and is due to calve again the first part of April, having carried a calf 171 days of her remarkable test."

Daily Ration of Segis Pietertje Prospect

Month of	Grain	Beet Pulp	Hay	Beets	Italian Rye Grass	Molasses	Oats and Peas	Sweet Corn
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Dec.	16	3	20	36	..	2	..	..
Jan.	22	5	25	56	..	2	..	..
Feb.	23	6	25	56	..	2	..	..
Mar.	25	6	30	56	10	3	..	..
Apr.	23	6	25	60	15	3	..	..
May	23	6	20	60	25	3	..	..
June	23	6	20	50	30	3	..	..
July	21	5	20	40	..	3	40	..
Aug.	22	5	22	35	..	3	35	..
Sept.	22	6	23	48	..	3	10	20
Oct.	22	6	25	56	..	3	..	25
Nov.	21	6	28	60	..	3	..	..
Dec.	21	6	30	60	..	3	..	..

Grain Mixture

6 parts ground oats
4 parts bran
3 parts corn meal
3 parts hominy
1 part cottonseed
2 parts soy bean
3 parts oil meal
1 part ground flaxseed
1 part gluten
1 lb. charcoal to 100 lbs. grain
Salt before her at all times
Molasses fed with pulp
From the above it will be noticed that she received approximately 1 lb. of grain to each 4.6 lbs. of milk produced.

XVII. Feeding for Long Distance Records

FIRST, we should define the term, long distance record. The author likes to think that the champion long distance dairy cow is the cow that will make a creditable seven-day record, follow it up with a good yearly record, and continue this sort of work for several years, producing a calf every year. The average productive life of a cow should be at least five years, with five calves. The profit in the pure bred business comes largely from the sale of the young stock, and this means numbers produced and large records. The cow should be tried out every year for a seven-day record in the hopes that she may improve her previous record.

The fitting of a cow for a seven-day test each year gives her a big start on her year's record, even if she does not improve her previous weekly record. Fifteen or twenty pounds of fat a week on the start of a yearly record makes a big difference in the yearly total. The easiest time to get this high production of fat seems to be about three weeks after calving. A study of many seven-day records shows that most of them are made at about that time.

THE FUNDAMENTAL PRINCIPLES

It is well to review at this time just what the food is used for. A cow making a long distance record is going to be a hard working animal all the time. After she freshens, she is under a tremendous load producing milk. Soon she is bred, and then to the work of milk production is added the labor of growing a foetus. The work of milk production demands a liberal supply of protein because the solids in milk are nearly 27 per cent. protein. This protein can only be derived from the feed that the cow eats. Then the growth of the foetus demands a liberal supply of protein. All the needs of the animal from a physiological point of view and from a commercial point of view also point to a liberal supply of protein in the feed. This means a relatively narrow ration, except when dry. The dry period is the time when there is the largest demand for protein for the foetus. From this standpoint, therefore, even when dry, the cow should have a liberal supply of protein. Any excess protein can be used for energy purposes. During the dry period the cow is laying on fat. A liberal supply of protein will help in this. The protein does not seem to be used in the actual formation of the body fat, but has a guiding influence in the nutrition of the animal at this time, causing the animal to fatten more readily with less expenditure of feed.

The carbohydrates of the feed are used for the manufacture of the milk sugar. The solids of the milk are about one-third sugar. This may be made from the carbohydrates of the feed or from the fat in the feed or from the protein, when there is more protein or fat than is needed for other purposes. Then the carbohydrates are used directly as a source of energy, either for direct consumption or stored as fat to be drawn upon later for energy purposes. Body fat in the young foetus or in the mother, is made in large part from the carbohydrates. In this sense the carbohydrates are as essential and as important as the protein, except in so far as the protein of the feed has special uses, and because of its nitrogen has a high manurial value. A pound of protein and a pound of carbohydrates have the same feeding value from the standpoint of energy.

The fat of the feed may be used to form body fat or milk fat or may be burned at once to yield energy. One pound of fat in the feed has two and one-fourth times as much energy as a pound of carbohydrates or protein. Therefore, fat is said to be two and one-fourth times as valuable as carbohydrates or protein. The fat has no special functions except as above outlined. A high amount of fat in a feed would not make a higher percentage of fat in the milk.

The amount of ash or mineral in the feed of cows has probably not received the attention that it should. This question is being carefully and thoroughly studied at the present time. Results of these studies will have an important bearing on long distance feeding. The question seems to center around the supply of lime and phosphorous. A large variety in the ration and legume roughage will help to solve this question.

FEEDING PRACTICE

Between lactations the cows on these long tests will go dry eight to ten weeks. A good grain mixture to be fed at this time with alfalfa hay and silage and perhaps a few roots, is 30 pounds hominy feed, 30 pounds ground oats, 30 pounds wheat bran and 10 pounds of oil meal. Feed liberally of this mixture and get the cow to fatten somewhat. If she is only dry for eight or ten weeks you cannot get her too fat.

Keep her on a rather light ration, using this same mixture for three or four days after calving, when she may be put on the test mixture and her allowance raised to the limit of her appetite. Whenever she shows signs of going off feed she may be fed a meal or two of the same mixture that has been suggested for her when dry.

She must be fed alfalfa hay or clover hay if she is going through two or three hard lactations. She must have good corn silage. She must have table beets or mangels. As a suggested grain mixture to be used as a test ration, the following is used by one of the best feeders and breeders of Holstein-Friesian cattle:

300 pounds distillers' dried grains
100 pounds oil meal
100 pounds hominy
100 pounds cottonseed meal
100 pounds ground oats
100-200 pounds wheat bran
100-200 pounds gluten feed

Such a mixture with alfalfa hay would give an abundance of protein. It may be modified in a hundred ways, but is efficient as it stands.

If handled and fed as suggested, to the limit of her appetite, a cow should produce heavily. She must be watched carefully and kept hungry. Alfalfa hay, silage, mangels and grain form the basis of the ration at all times of the year, but advantage may be taken of pasture, if exposure to bad weather is not allowed and the cow is pastured only when flies do not plague. She must be pampered and protected and watched. Care will be rewarded: Cows that are worth while are entitled to all they will eat all the time.

XVIII. Summer Rations for Semi-Official Cows

THERE is not much difference between the summer rations for semi-official cows and the rations fed at at other times of year. The principles are the same, plenty of succulent feed and a good grain ration. The cows that have made the best semi-official records have not depended very much on pasture, although many of them have been allowed some pasture. Pasture is undoubtedly ideal so far as the feed is concerned. The drawbacks are many, however. The cow must spend much energy in getting her feed and in making a high semi-official record; she has not the energy to spare for this extra work. Second, if she must depend much on pasture, she is exposed to all kinds of weather. This is not good for her. She must not be chilled. Third, and worst of all, if she goes to pasture in the day-time, she is open to the attack of flies. There seems to be no fly remedy on the market as yet that is completely a repellant. They will keep them off for a while but their effect will not last for the full day.

Therefore it seems best to depend on soiling crops and a good grain ration. If the cows are turned to pasture at all they should be carefully sprayed and watched so that as little trouble can come from flies as possible. The cows should be petted and pampered more or less and fed all they will possibly eat all the time. Their individual likes and dislikes may be studied to good advantage, and the cows pleased in this way. The secret is in getting them to eat and keep in good health. They cannot make the best use of this food if they must use the energy for other purposes than milk production or are distracted by improper stabling or exposure to bad weather and flies.

The author happens to have at hand the detailed feed records for May, June, July, and August, of two cows that have made over 1000 pounds of butterfat in one year. The feeding of these cows for these summer months must have been good or they never could have made these high records.

The first was fed as follows:

May, 1914. 17.5 lbs. grain daily of the following mixture: 3.8 lbs. bran, 2 lbs. hominy, 3 lbs. ground oats, 1 lb. each, wheat feed, flaxseed meal, and oil meal; 4.5 lbs. distillers' dried grains, 1.2 lbs. gluten, 14 lbs. roots, 46 lbs. ensilage, 10 lbs. alfalfa hay, pasture one hour.

June, 1914. 15.5 lbs. grain daily of the following mixture: 5 parts bran and corn, distillers' dried grains, 1.5 part hominy, 4 parts ground oats, 5 parts cottonseed meal, 1 part each, Bartlett's sugar malt, Buffalo gluten, flaxseed meal and oil meal; 3 lbs. beet pulp, 41 lbs. ensilage, 10 lbs. green alfalfa, and 11 lbs. alfalfa hay.

July, 1914. 18 lbs. grain daily, same mixture as given in June: 2 lbs. beet pulp, 15 lbs. each, red beets and green alfalfa; 10 lbs. sweet corn, 42 lbs. ensilage, 11 lbs. alfalfa hay.

August, 1914. 15.2 lbs. grain daily, 14 lbs. of the following mixture with 1.2 lbs. oat feed added daily; 4 lbs. bran, 2.5 lbs. hominy, 3.5 lbs. ground oats, 5.5 lbs. corn, distillers' dried grains, 2 lbs. Bartlett's sugar malt, 5 lbs. Buffalo gluten, 1 lb. each, cottonseed meal, and O. P. oil meal; 2 lbs. beet pulp, 20 lbs. beets, 15 lbs. each, sweet corn and alfalfa; 36 lbs. ensilage, 9.5 lbs. alfalfa hay.

Another cow that made 1000 pounds of butterfat in one year was fed as follows:

May, 1913. 10 lbs. grain daily of the following mixture: 250 lbs. bran, 50 lbs. each, hominy, cottonseed meal, and oil meal; 100 lbs. gluten, 3 lbs. beet pulp, 2 lbs. molasses, hay with pasture.

June, 1913. 19 lbs. grain daily of the following mixture: 250 lbs. bran, 50 lbs. each, hominy, ground oats, cottonseed meal and oil meal; 3 lbs. beet pulp, 2 lbs. molasses, green feed.

July, 1913. 18 lbs. grain daily of the following mixture, on 1st and from 11th to 31st; 15 lbs. daily from 2nd to 11th; 250 lbs. bran, 50 lbs. each, hominy, cottonseed meal, ground oats, and oil meal; 100 lbs. gluten, 3 lbs. each, molasses and beet pulp; corn fodder from 1st to 15th; clover from 17th to 31st.

August, 1913. 18 lbs. grain daily of the following mixture: 250 lbs. bran, 50 lbs. each, hominy, cottonseed meal, and oil meal; 100 lbs. gluten, 3 lbs. each, beet pulp and molasses; corn fodder, alfalfa, clover, with pasture.

The first grain mixture is a little more complicated than the second, due to the addition of sugar malt, not a common feed, and it is doubtful if it made the ration any more efficient because the record of the second cow is practically as great as that of the first.

To show the kind of feeding practiced at Cornell University, the feeding of a young cow for the months of May, June, July and August, is given. She made a yearly record of 620 lbs of butterfat, was dry eight weeks and then made a seven-day record of 24 lbs. of butterfat, which put her in the 30-lb. class. Her 30-day record in this lactation was 2481.1 lbs. milk, 94.129 lbs. butterfat.

Her feed record for May, June, July, and August, 1915, was as follows:

May. 15 lbs. daily of the following grain mixture: 300 lbs. distillers' dried grains, 200 lbs. hominy, 200 lbs. wheat bran, 200 lbs. cottonseed meal, 100 lbs. gluten feed, 50 lbs. corn silage, 11 lbs. of hay. The last of the month the hay was dropped and some green grass fed.

June. 12 lbs. daily of the same grain mixture as in May. All the green feed (grass, peas and oats, etc.) she would eat.

July. 14 lbs. daily of the same grain mixture as in May; 50 lbs. green alfalfa until July 17th; July 18 to 24, 30 lbs. peas and oats silage; July 25 to 31, 30 lbs. corn silage.

August. 9 to 14 lbs. daily of the same grain mixture as in May; 30 to 35 lbs. daily of corn silage; some pasture and hay.

These three statements of actual rations fed show the kind of ration, the feeds used, and illustrates again the need for succulence, variety, plenty of bulk, and plenty of protein in the ration.

A study of many rations fed by many different feeders will show that they do not depart widely from these methods, and the feeds listed in these rations will cover those generally used.

The following is suggested as a grain mixture for the summer:

500 pounds hominy
500 pounds distillers' dried grains
300 pounds wheat bran
300 pounds gluten feed
200 pounds oil meal
200 pounds ground oats

XIX. Feeding Fat Into Milk

EVER since interest in high production records was stimulated by the dairy breed associations, breeders have looked for ways and means of raising the normal percentage of fat in a given individual cow's milk for seven, thirty, or longer periods of days, including semi-official and official yearly records. The writer has never yet seen but one way of doing this successfully. Many breeders have been sure that they had a way, but no one way has been successful enough to give that breeder any lead over others. And so far as the writer is aware no method has ever been tested out carefully and scientifically except one. That one method is to fatten an animal before the testing period and then feed her carefully so that she will lose her body fat and put it into the pail. This method has been described in a previous paper and is really so well known among breeders who test that it is unnecessary to give it much more consideration here.

And after all, what would the economic effect of a successful method to feed fat into milk in a short time test amount to? The partial success of feeding fat into milk by means of fattening the cow before testing, has already brought seven-day records into more or less disrepute as real evidence of production. The law of conservation of energy holds true no less with animals than with machines, and if a method of changing body substance into milk fat is found, the same amount of food must be used to produce the body substance at some time in the course of the period between the birth of two calves.

No, in the opinion of the writer, breeders who seek to find a method to increase the percentage of fat in the milk of any individual for any period of time, short of the whole life of the individual, is not doing himself or the breed any real

good. The breeders of the Holstein-Friesian breed had better give their attention to the study of methods of breeding, which may on the one hand increase the normal fat content of the milk of the breed, if that is deemed desirable, and which must be done at the expense of a less quantity of milk, and on the other hand, to methods of breeding which will increase capacity of the breed as a whole, to utilize feed above maintenance and change it into milk. Suppose a method should be found which would cause a cow to test higher than her normal inherited percentage for seven or thirty days or even a year. What good would that do the breed? Until it was established beyond doubt that a certain breeder was doing something which was influencing the production of his individuals for short periods of time, of course he would make money, but it would be a great boon to the breed if some way could be found to enable a cow to turn more food into milk: but it is the firm conviction of the writer that it is futile to look for methods of this kind except through breeding for greater capacity and production. This kind of work will permanently better the breed.

To be sure of his ground, the writer has looked over rather carefully the literature on this subject in recent years, by consulting the Experiment Station record. The only positive evidence that appeared was found in Bulletin 100, by C. H. Eckles, of the Missouri Experiment Station. Eckles' work was wholly along the line of feeding the animal previous to the beginning of the test and getting her fat. When this was done the percentage of fat in the milk would be high during the first part of the lactation period. The effect persisted to a more or less extent through the whole lactation period. This kind of feeding is to be advised, because undoubtedly the capacity of the animal to produce is increased in a perfectly legitimate and normal manner, and it is a case of actually turning more feed into milk.

The experiments along the line of the specific effects of different feeds have been very numerous, but any positive effect of any one feed or combination of feeds is shown to be short and slight. It is probable that in many cases the effect could be shown to be within the limits of experimental error if a careful study were made.

A number of experiments on the use of the extracts from certain glands of the body, particularly the pituitary gland, for the purpose of increasing the percentage of fat in milk, and also for increasing the amount secreted, have given positive results for short periods of time, but these results usually

have been followed by corresponding periods when the amount and quality have been below normal.

Some positive results have been obtained by feeding a large amount of oil and fat in the ration. These experiments also have been attended without permanent results which would influence one to recommend definite procedure even for a short time test.

In conclusion the author must confess that he sees little hope for any method for really increasing the fat percentage in milk, except through breeding and feeding to produce cows nearer the ideal that is held for the breed in question. The true method to get cows with high records is to breed for size and capacity, and perhaps if that is the desire and ideal of the breed, to select for a higher percentage of fat.

Part Three—Feeding Calves

XX. Raising Calves on Whole and Skimmed Milk

THE raising of dairy young stock is a very important problem for our farmers. The feeding and management of stock is fully as important as the breeding, although we are likely to say that breeding is more important. It is in this sense, the animal must have the quality if is going to do the work in the world that is expected of it. First, after being well born, comes the necessity of being well fed as a calf. This will be the subject of this and the next paper. This paper will consider the growing of young calves on milk.

There are three possible ways of growing calves on milk:

1. The use of nurse cows, good producers but of grade breeding.

2. The growing of the calf on whole milk.

3. The growing of the calf on skim milk.

The growing of calves by means of a nurse cow does not need any particular explanation. A good cow costing $50 to $75 should be able to care easily for two calves and grow them in the very best possible condition. This method lends itself to practice in those places where there is abundant pasture on cheap land, and it goes without saying that this method would produce the very best calves. But as is shown in a table a little farther on, this is of course a very expensive method.

The second method is also expensive, but is the method used by the breeders who are growing the best stock. This method means the feeding of the calf on whole milk after two or three days, while he is left with his mother. This method is also expensive, but there is a bloom and finish put on the calf that cannot be obtained in any other way. The best breeders are not content with feeding in any other manner. The details will not be discussed because all details are practically the same as when feeding skim milk. This method of feeding is the one on which, by far, the majority of breeders must depend, and it will be discussed in detail. It seems best to take up the discussion by weeks in order to be definite.

The First Two Weeks.—After the calf is born he should be left with his mother for two or three days. Perhaps until the eighth milking. The writer has always considered the eighth milking "good" to save for home or market purposes. The milk of the first six or seven milkings is called colustrum. This is necessary to the health of the calf because it is a laxative and has a good effect on the digestive system. It has always seemed to the writer that the best way for the calf to get the colustrum is by suckling the mother. It is best for the mother, too. If the calf does not attempt to suckle the mother by the time he is three or four hours old he should be helped up and assisted in getting his first meal.

He should get whole milk for at least ten days. If at all practicable it is best to feed him for the first ten days, three times a day, one and one-half quarts at a meal. After the tenth day, if he is good and strong, he may be fed twice a day and receive two quarts (four pounds) at a meal. The temperature of the milk should always be at 90 degrees to 100 degrees F. A thermometer costs twenty-five cents. Always try the temperature of the milk with a thermometer and know that it is at the proper temperature when fed. The temperature is one of the most important points to have correct in feeding. Beginning with the eleventh to the fourteenth day the calf may be changed to skimmed milk.

The Third Week.—Take a full week from whole milk to skimmed milk, changing at the rate of one pound per day. The skimmed milk must be sweet, free from foam, and at a temperature of 90 degrees to 100 degrees F.

The Fourth Week and Thereafter.—The calf may now have more milk as his appetite and condition demand. Do not over-feed him. There is much more danger from over-feeding than from under-feeding. Mix into each feeding of skimmed milk a teaspoonful of soluble blood flour. This blood flour may be obtained from your feed dealer. It is simply dried ground blood and is a by-product from the large abattoirs. Insist that the kind you buy be very finely ground, because coarsely ground dried blood will settle out when mixed in the milk, and it should stay in suspension. Blood flour is expensive, but the amount fed is very small and is worth many times its cost. Its particular usefulness is twofold, it is a very good high protein in itself, and secondly, it keeps the bowels of the calf in good condition and overcomes any tendency to digestion troubles.

Roughage.—At four weeks of age the calf will begin to

eat food other than milk. The best roughage for him is second or third cutting of bright, well cured alfalfa hay. On those farms where alfalfa hay is not available, the second cutting of clover hay is best. With a little care practically every farmer in the State of New York can put up a little cutting of clover hay for his calves. If neither of the above kinds of hay are available, use the best quality of hay that can be secured. Let the calf have all the hay he will eat.

After the calf is six months old he may have a little silage.

The Grain Mixture.—At about the time at which the young calf will begin to eat a wisp of hay, he will eat dry grain. The mixture that has given the writer much satisfaction is the following: 30 pounds wheat bran, 30 pounds ground oats, 30 pounds corn meal and 10 pounds oil meal. The calf should be fed all he will eat of this mixture in a box nailed to the side of his pen. Never feed a calf dry grain in the pail from which he gets his milk, nor mix the grain in with his milk. When three or four weeks old, after he has finished drinking his milk, put some of the above mixture in his mouth. He will soon learn to like it. At the same time have some of this mixture in the feed box in his pen. He will soon find the box and eat regularly. Feed all the grain he will eat up clean after having his milk. Some feeders keep feed before their calves all the time.

Care and Management Other Than Feeding.—Besides feeding there are some other things in the care of the calves that should be mentioned. More than all else is cleanliness and dryness. The pens should be kept clean and dry. The temperature of the stable may be rather low and the calves will grow and thrive if kept dry and clean and are well fed. The pens should be cleaned often and kept well bedded. In warm weather particularly, the calves should have access to clean water.

Many farmers turn their calves out to pasture when too young. In New York, a good practice is, keep in the barn during the summer all calves born after February 1st. These young calves may be turned out at night pasture if one is available. They are too young to pick their own living without some extra food, so that it seems best to feed them in the barn the first summer. In the pasture flies plague them so that they do not grow well.

Dehorning Calves.—In herds where it is desirous that all the animals shall be dehorned, the best time is to dehorn the young calves before they are three weeks old. This may

be done by rubbing the little nubs of horns with a stick of caustic potash. This may be purchased at any drug store. When using it, precaution should be taken that it does not come in contact with the hands. This is easily done by wrapping in paper the end of the stick that is held in the hand.

Clip the hair away from the button of horn. Dip the end of the stick of caustic potash into water and rub the horn hard with it until the skin all around the button is raw and bleeds a little. This is necessary in order to wholly destroy the horn tissue. Be careful that the caustic liquid does not run down into the eyes of the calf.

This seems like a cruel practice, but in reality it is a most humane one, because it does not hurt the calf very much, and dehorning a mature animal is very painful and more or less dangerous. Cattle that have been dehorned are more docile, cannot injure each other, or the attendant, and are probably more productive. The sores made by the dehorning process will quickly heal and need no attention. The thing of greatest importance is to do a thorough job, making sure that the horn button is absolutely destroyed. If only a part is destroyed a stubby, misshaped horn will grow and a poorly shaped head will result.

Much trouble is sometimes experienced from scours arising from indigestion. This trouble is to be prevented rather than cured. It may be prevented by proper feeding. The above directions have been followed in a herd of sixty calves and the calves made an average gain of ten pounds and over per week. Blood meal has been used religiously, and when a little trouble has come the only treatment that has been necessary has been to cut down the food at least one-half and to add a pint of clear lime water for a feed or two. Then bring the calf gradually to full feed again.

The following table shows the comparative cost of feeding according to the three methods mentioned:

Food	Pounds average daily gain	Feed cost of 100 lbs. of grain
Skimmed milk	1.5	$2.26
Whole milk	1.9	7.06
Running with dam	1.8	4.41

This table is from the actual results in handling a total of forty-two calves divided about equally into three lots. The feed cost would vary with the locality, but shows a comparison that might reasonably be expected. The comparison shows that skimmed milk is by far the least expensive, and a daily gain of 1.5 pounds will give a heifer that will be

so well developed that it will be very difficult to recognize her from her sister, raised on whole milk, when both reach the age of two years.

XXI. Raising Calves on Substitutes for Milk

ON MANY farms there is need for method of feeding calves with a small amount of milk. The breeder has not yet reached the place in his business where he can afford to feed his calves on whole milk, although this is by far the best method for raising the calves to get that fine finish desired by buyers of the best bred stock. Neither is there available a supply of skimmed milk. The small breeder must send his raw milk to market and if he is to raise the herd and breed it up according to his own individual ideas, he must breed and raise his own young stock. How can he do this with a minimum of whole milk?

There are two general ways open to him: (1) He can purchase and feed the commercial calf meals on the market. (2) He can mix up his own calf meal. Both of these ways have been tried out carefully on many farms and at several experiment stations, so that we know that good dairy heifers can be raised on substitutes for milk. In test of these calf meals alongside check groups raised on skimmed milk at two years of age, it has been found that there is no difference in development. The young calves do not grow quite as fast at first but soon pick up after six months of age, and, at two years of age, there is no appreciable difference. In our experience there has been no difference in productive ability that can in any way be attributed to the fact that the calves were raised on substitutes for milk.

The importance of this cannot be overestimated. We must interest all our dairy farmers to raise and breed their own stock. Many farmers do not raise their own stock simply because they can not see any way to raise the calves without milk. Therefore they maintain their herds by purchase. It is a great gain for the industry of dairying every time a farmer can be interested to improve his herd by his own breeding.

COMMERCIAL CALF MEAL

Feed manufacturers in the past few years have greatly increased the number of commercial meals on the market. They are all much alike as to ingredients. It will not be possible to name all the commercial calf meals on the market or to give their ingredients. Each farmer in selecting his

calf meal must judge of its merits. Since we cannot name them all and give results for each, it is only fair that we do not name any. It is suggested that those meals will probably give the best results which are made up from the ingredients that we know to be suitable for feeding young animals. It is required by law that all the ingredients be named. If there seems to be any ingredients in the mixture that might not be suitable do not feed that meal but buy another which has suitable ingredients.

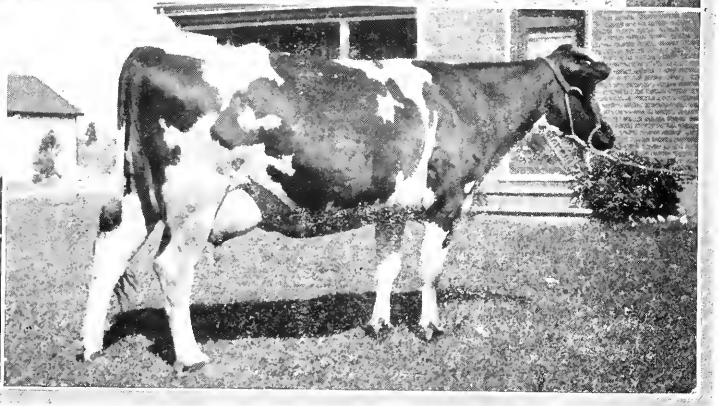
Feed the commercial calf meal that you select according to the methods suggested by the manufacturer. In trials conducted by the author, covering a period of eight years, with several commercial feeds, the methods recommended by the manufacturers have been followed generally with good results. We have had no trouble in getting calves to gain at least one pound per day with commercial calf meals, and gains of 1.5 pounds per day have been common. No one should be satisfied with a gain of less than one pound per day. All the precautions and methods of supplementary feeding, to be used with skimmed milk, must be scrupulously carried out with commercial calf meals, because these meals are a much more artificial way of feeding than skimmed milk and more likely to cause trouble. Extra care must be taken not to over-feed.

The one thing that the author would emphasize with the commercial calf meals, is that fact that they are too high in price. They cost from $60 to $70 or more per ton retail, whereas a good home-mixed calf meal has given better results than the average commercial meal at a cost of $40 to $50 per ton.

A HOME-MIXED CALF MEAL

The Purdue University Experiment Station has used extensively a home-mixed calf meal, simple in its make-up and within the reach of all. Any feed dealer can procure the ingredients, if you insist that he get them for you. You should be able to mix it at present prices of feeds, for $50 or less per ton, with the ingredients purchased at retail. The mixture is equal parts, by weight, of linseed oil meal, hominy feed, red dog flour, and soluble blood flour. The table below suggests the method of using the home-mixed calf meal.

Table showing the daily amount of milk, calf meal and water required by calves of various birth weights and various ages:



SPRING BROOK BESS BURKE 2d

Four year records from 1000 to 1290 lbs. Four 7-day records from 30 to 38 lbs. Weight, 2225 lbs.

TILLY ALCARTRA

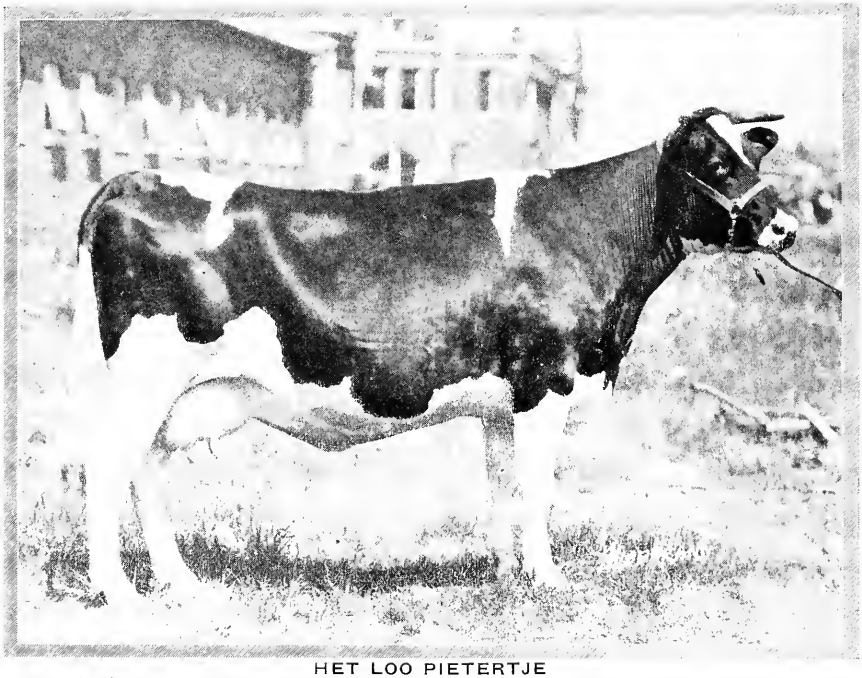
Long distance champion producer over all breeds. Twice above 30,000 lbs. milk in a year.

SEGIS PIETERTJE PROSPECT

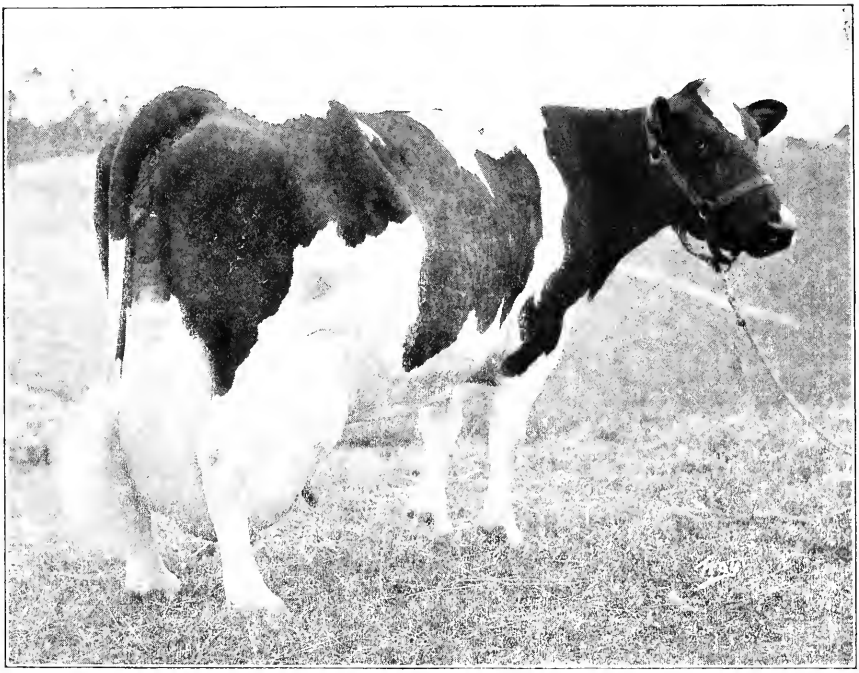
Famous 37,000-lb. world's champion milk producer in year's test.

BELLA PONTIAC

Year's record—1587.50 lbs. butter. Champion over all breeds.



HET LOO PIETERTJE
At 2 years—30.22 lbs. butter in 7 days. World's champion in her class.



GLISTA ERNESTINE
The only cow to make above 30 lbs. butter in 7 days, seven different years. She produced over 800 pounds milk in 7 days two different years. Conditioned and tested under Prof. Savage's feeding methods.

Birth weight of calves lbs.	Daily ration at 5 days of age	Daily ration at 7 days of age		Daily ration at 20 days of age			Daily ration at 30 days			Daily ration at 40 days of age	
	Milk lbs.	Milk lbs.	Meal oz.	Milk lbs.	Meal oz.	Water lbs.	Milk lbs.	Meal oz.	Water lbs.	Meal oz.	Water lbs.
40	5	6	2	4.5	8	2	1	13	5	14	6
50	5	6	2	4.5	8	2	1	13	5	14	6
60	6	7	2	5 0	9	2.5	1	14	6	15	7
70	6	7	3	5.0	9	2.5	1	14	6	15	7
80	7	8	3	5.5	10	3	1	15	7	16	8
90	7	8	3	5.5	10	3	1	15	7	16	8
100	8	9	4	6.0	11	3.5	1	16	8	17	8
	Calf to be taken from cow and fed from bucket at this age.	Begin adding water to the meal after ten days of age.								If calf is doing well, discontinue milk feeding after this age.	

This table is taken from Purdue University, Department of Agricultural Extension bulletin No. 44, published in January, 1916.

This table may be followed in detail or a simple rule used by the writer, which checks almost exactly with the table, is to mix one pound of dry meal with eight pounds of water at 100 degrees Fahrenheit and use this gruel just as one would skim milk, taking five weeks for the complete change from milk to gruel.

The one thing to be careful about in using this method of raising calves is not to over-feed. Several lots of good looking calves have been raised by the author and no trouble has been experienced in getting the calves to grow at least one pound per day per head. Much better gains may be made with Holstein calves when the feeder uses care enough and makes pets of his charges.

XXII. Feeding and Management of Yearlings and Two-Year-Olds

FROM the standpoint of the best development of the heifer at the least cost, fall-dropped calves are preferred. But this is not possible for all calves since it is necessary and wise to control the breeding of the herd so that the milk flow is maintained at about the same rate for the herd through the year. When a farmer can turn out about so much milk per day through the whole year, he can

command a better market because of the uniformity of the amount of his product.

It is not wise to pasture during their first summer, calves dropped after January or February first. Flies bother the young calves too much. Calves that are born before January first seem to stand their first summer on pasture all right and make good gains. Therefore, the cost of raising a heifer dropped during the fall is likely to be less than that of one dropped later because of the greater utilization of pasture. Pasture is very cheap feed any way it is computed unless one has to give a greater valuation than $50 per acre to the land.

If skimmed milk is available it may be used to good advantage until calves are a year or more old, although it is not at all necessary after eight months. It will probably give greater returns, fed to younger animals, than to those over eight months. When calves or other young stock are on pasture there is no greater pleasure to them than a cool, dark basement, into which they may run during the heat of the day and get rid of the flies. If the basement is made rather dark the flies will leave them.

If any of the herd of calves seem a little unthrifty it is a very good thing to arrange matters so that these can have a little grain to supplement the pasture. Of course there are any number of feeds available for this purpose. A mixture that is a favorite one with the author for all young stock is the one already mentioned in feeding calves, 30 pounds hominy, or corn meal; 30 pounds of ground oats; 30 pounds of wheat bran, and 10 pounds of oil meal. If pasture is good perhaps no grain will be needed during the best months. The amount of grain necessary for heifers is about four pounds per day up to the time of calving, of such a mixture as the above. All the good clover hay and silage that she will eat, and four to six pounds of grain, will keep the heifer in good growing condition and put her in the right shape for dropping her first calf. There are many other feeds and mixtures as good as the one given above. Space will not be taken to give other mixtures. Distillers' dried grains, gluten, cottonseed meal after one year of age, brewers' dried grains, malt sprouts, barley, buckwheat middlings, etc.; all make excellent ingredients and may be used for rations for grow-

ing stock. Some high protein feed should always be included in the mixture to enable the animal to make satisfactory growth. Experience and observation prove that the animal which grows the most regularly and rapidly during the first two years of her life will make the most satisfactory producer.

Many times it is said that feeding fattening foods is to be avoided, and much fat on a heifer is considered wrong by many. It is the writer's impression that there is little danger from getting a heifer too fat. Keep her growing and in good condition all the time. In this paper the amount of grain has been placed at four to six pounds. It seems to the writer that this is a good plan in feeding, to allow them to fix the total amount of the ration by feeding all the silage and hay that they will eat.

The time at which heifers should be bred is an important point to be considered in the management of heifers. There is a tendency among purebred breeders to breed at 20 months of age or even later. A few figures from a good pure-bred herd on this point gives a good reason for early breeding.

Thirty-three animals produced their first calf before they were 30 months old. Their two-year record was 6026 pounds. Their three-year record was 6780. Eighteen animals that produced their first calf at 36 months or a little later made an average of 7460 pounds of milk in their third year. The first lot has produced at the end of their year almost 13,000 pounds of milk against 7500 for the second lot. In later years the second lot did not appear to do any better than the first lot. Until she becomes a milk producer the heifer yields no income. There are 4 good reasons for breeding early in addition to the above: (1) Constantly recurring periods of heat are as much a check on the heifer's growth as the development of the foetus. (2) Reproductive organs may become deranged if breeding is put off. (3) The condition of pregnancy has a marked stimulative effect upon the young animal during the first months. The assimulative functions are increased provided the heifer is furnished with an abundance of food. (4) It seems to be easier to develop a milk-secreting capacity when the heifer produces young at an early

age. If put off sometimes the heifer shows a tendency toward beefiness. On the whole it seems best to have the heifer drop her first calf at 24 months. In conclusion, this paper is a plea for liberal feeding of heifers and early breeding.

Part Four—Miscellaneous Articles on Feeding

XXIII. Feeding Dry Stock

ALL authorities on dairying agree that cows should have a rest between lactation periods. Opinions differ as to what the length of that period should be. Pure-bred breeders who do much advanced registry testing are often accused of milking their large seven-day-record cows only six months in the year. This criticism is for the most part unfounded. A cow needs to make a big yearly record. From reliable sources of information it seems that two months is about the correct length of time for a cow to rest. From data on 496 cows in a cow testing association, those cows dry for two months produced more butterfat and made a larger net profit per year than those which were allowed to rest only one month.

Eckles, of Missouri, regards a period of six weeks long enough unless the cow is thin in flesh. So far as there is available data it seems to make no difference in average annual returns per cow, whether the lactation period is nine, ten or twelve months long, so long as there is a rest period of six to eight weeks between lactation periods. It is usually best, however, to plan the breeding of the herd so that each cow will produce a calf once a year. Whether all the cows will be bred to come in in the fall or spring must depend on the market for milk and the market for stock. A little attention to time of breeding will enable a breeder to keep the amount of milk produced daily uniform for the year. His particular market may be better for his surplus stock at one time of year than at another. For the greatest success all these points must be considered in fixing the time for breeding each cow.

There are some cows that it is difficult to dry off. All cows should be dried off gradually. If the cow is giving a lot of milk when it comes time to begin the rest period, her concentrate allowance should be withheld, and if necessary, her roughage limited to timothy hay, although it is seldom necessary to go to this extreme. Milk her once a day for several days, then but once in two days and so on, gradually

lengthening the period between milkings. When she produces ten pounds per day or less milking may be entirely discontinued with safety, although the cow must be carefully watched to see that the milk becomes re-absorbed.

After the cow is dry she should be fed liberally on roughage. Alfalfa hay and corn silage are good at this time. Scientists, notably Forbes of Ohio, are beginning to study carefully the amount of the different minerals removed in the milk. The amount of lime is particularly large and the ration fed during the lactation period does not seem to supply enough lime in such a form that it can be easily assimilated. Therefore more lime is removed in the milk than is assimilated from the feed during a given lactation period. This lime can only come from the skeleton of the animal. She must restore this amount while dry. This, then, is one very important reason for feeding leguminous roughage. Legumes furnish a large amount of lime in a form more easily assimilated.

Succulent feed is important at this time, as at all times, in feeding dairy cattle. It is healthful, cooling, and keeps the animal in the very best condition.

The grain ration may be made up from various feeds. Variety is not so important nor is bulk at this time. The mixture may be made from any feeds fattening in nature, for the aim now is good health and vigor and some added fat. The author has used the following mixture of concentrates most successfully in feeding dry cows:

600 pounds hominy feed
600 pounds ground oats
600 pounds wheat bran
200 pounds linseed oil meal

This mixture will put the cows in first-class physical condition and will insure proper growth of the foetus. Another mixture used for two-year-old heifers soon due to freshen for the first time, and to dry mature cows, was:

500 pounds gluten feed
500 pounds ground oats
500 pounds hominy feed
400 pounds wheat bran
100 pounds oil meal

Oil meal, though usually relatively expensive, is particularly valuable at this time to put the cows in good condition. The exact makeup of the mixture will depend, as so often said in this series of articles, on the feeds available at home and the relative cost of total digestible nutrients in those concentrates that must be purchased. The principles on which

the above mixtures rest are relative cost of digestible nutrients, a good amount of high protein feeds and the rest fattening feeds with a little oil meal as a conditioner.

It is a common statement among the most progressive dairymen that the grain fed at this time brings in the greatest returns of any, and that means a larger, stronger calf, a cow in stronger, better condition to stand the strain of parturition and a good send-off into a new lactation and a good high production. he fat on her back while dry, by a cow of good dairy temperament, will all eventually return to the milk pail, in that she will lose in weight during a period of four or five weeks after calving and her milk will be richer in fat during this period than it otherwise would. Both of these facts are borne out by the results of careful experiments at the Missouri Experiment Station.

The amount of concentrates to be fed daily will depend on the roughage. With a liberal supply of the best roughage, when grain is not exceedingly high, four pounds a day should be fed. With valuable cows, when records are in view, ten to twelve pounds would not be excessive.

In conclusion, it may be interesting to note some of the rations fed to dry cows in a country where the cows are just "roughed" through the winter. Monrad says that in Norway cows are often wintered on small farms on straw, birch leaves, reindeer moss and horse dung, cooked and given as mash with straw and leaves. Herring, fish offal and seaweed have been used in the same way. The annual yield of milk under such conditions was 1600 to 1800 pounds. The cow has always responded wonderfully to every improvement in the method of caring for and feeding her since these primitive dairy methods were in operation.

PERTINENT INFORMATION

Criticism of purebred breeders, tending to show that they milk large record cows but six months in a year, is unfounded.

Two months is about the correct length of time that cows should rest between lactation periods.

The time when cows should freshen is dependent upon the market for milk and the market for stock.

A little attention in time of breeding will enable a breeder to keep the amount of milk produced daily uniform through the year.

All cows should be dried off gradually.

Leguminous roughage should have a large place in the ration of dry cows. It furnishes lime in a form easily assimilated.

Expenditures for grain to be fed to dry cows bring in the greatest return. They mean a larger, stronger calf, a cow better able to stand the strain of parturition and a good send-off in a new lactation period of high production.

A cow always responds wonderfully to every improvement in methods of caring for and feeding her.

XXIV. Feeding and Care of the Dairy Bull.

MUCH is written and said about the feeding and the care for the dairy cow. Sometimes a short paragraph or two is written about the method of leading or exercising the bull, but very few men have a true appreciation of the importance of the bull in the herd, and he does not come in for his share of the study of feeding, exercise and care. In feeding the dairy cow the results are at once apparent. In feeding and caring for the bull the results are not at once apparent, and oftentimes the bull is dead before his real value is known. The writer has in mind the care of a very prepotent bull, that was the sire of several thirty-pound daughters, but his value was not recognized and he was not kept. He was sacrificed early, not because he was poorly fed or cared for, perhaps, but this may have had something to do with it. If he had been properly cared for and kept in the best condition it perhaps would not have been so easy for the owner to sacrifice him, and he would have been kept longer and his value, through his daughters, recognized before it was too late.

In breeding and managing purebreds we cannot put too much attention on the bull. He is so important. At present, in raising pure-bred cattle, we are taught that nearly all is in the breeding, and that the good or ill that there is in the offspring is purely the result of heredity and that nothing can be acquired during the life of the individual that can be transmitted. Undoubtedly this is all true, except perhaps in one particular, that is, in size and capacity. Feeding and care and management do have an effect on size and on constitution, and in the opinion of the writer, there is some transmission of these characteristics to the offspring. Good envronment and liberal feeding will aid judicious selection very materially in increasing th esize and capacity of the indviduals iin any given family.

If this is true, then how great is the importance of properly growing the males that are to be used for service, and how great is the importance of properly feeding, exercising

and caring for them during their use in the herd. The individual female in a given herd of twenty animals influences the outcome of only one mating in any single year. The individual bull puts his influence into twenty matings every year and stamps his individuality on twenty offsprings, where an individual cow affects only one offspring. The care, feeding and management in this herd, then, of the bull, is as important from a breeding standpoint as the care and management of all the cows put together and twenty times as important as the care and management of any single female of the herd. We do not wish to exaggerate this point and we do not think we have. We are only trying to emphasize and drive it home. The income from the breeding of the herd is always more important than the income from milk, and in many of our best and largest herds the milk is practically a by-product.

THE YOUNG BULL

For the first six months of his life the young bull will be treated as his sisters are treated. Skimmed milk, or whole milk in some cases, with good hay, a little silage and all the grain he will eat, and an opportunity to grow and exercise some, is all that he will require. Calves born before January first may be pastured the first summer if grained a little to secure maximum growth. If born after January first, it is better to keep them up, at least during the day, to be rid of the fly nuisance. A good grain mixture is three parts of an equal mixture by weight of hominy feed, wheat bran, ground oats, with one part of oil meal. Good legume hay, silage and four to six pounds of the above grain mixture should be very liberal feeding for the second six months. Perhaps the above suggestions are too liberal. Maximum growth is what is wanted and if that can be attained with less feed, that is all that is necessary.

The bull at twelve months is not to be considered mature by any means, but he should be ringed and taught that the one who controls him is master. If he has not been taught before, he should be taught to lead and be handled every day. If this is done and he knows who is master, a bull will rarely become ugly or hard to manage. At ten to twelve months he can be used for light service.

From now on exercise is the all important thing. Unless there is a particular reason for it, all animals, males and females, should be dehorned as calves. The sooner this becomes the fashion and it becomes the recognized thing, a

great thing for the comfort of our animals and their caretakers will have been accomplished. When this has been done bulls may be turned together and they will get a great deal of exercise pushing and ramming each other around and will be much quieter and easier to handle.

Exposure to the weather will do no harm and is a positive factor for good if the exposure is not undue. Practically all that is needed, except in very severe climates, is a shed closed on three sides and open on the warm side to the paddock, where the bulls may run.

In herds where only one bull is kept, additional means must be provided to secure more exercise than the bull will take of his own accord. Then in herds where sales are going on all the time, and it is necessary to keep the herd bull in more or less of a show condition, he must be regularly exercised in a more artificial manner. A tread power will do this or he may simply be led or driven. The important thing is exercise and plenty of it. One of the most valuable bulls of the Holstein-Friesian breed is given two miles every day on the road. The owner considers that the time thus spent is more valuable than the same time spent in any other way.

The feed that the bull is given must be commensurate with the service and his condition. He should not be too fat, but must be in good rig. Clover or alfalfa hay, ten to fifteen pounds of silage, and two to ten pounds of grain, is indicated. The silage should be restricted or he may become too paunchy to reach the cows. The grain mixture may be the one given above or a similar one, or may be the regular grain mixture given the herd. It should not be fattening, but should be rather bulky with plenty of protein, with at least a pound a day of oil meal.

In conclusion, we again call attention to the great value of the bull, value lost sight of because it is not so apparent each day as is the daily milk yield of the cows, but there, nevertheless; and to the great necessity of exercise for the aged herd bull every day, and then more exercise.

Part Five—The Sources of Feeds

XXV. The Sources of Feeds

THERE are three main lines of study in learning more about feeding dairy cattle.

1. We should learn all we can about the principles of nutrition which underlie all our practice.

2. We must learn all we can about what Dr. Armsby calls the "Materials of Nutrition", the feeds.

3. We must learn all we can about the practice of feeding itself.

It is with the second paragraph that this series of articles on the source of feeds will deal. We will try to teach something about the feeds that may be used in the feeding of dairy cows and attendant young stock.

RELATIVE VALUES

It is impossible to teach about feeds unless something is said about relative values. Whether one will use much gluten feed in his ration or whether he will use cottonseed meal depends largely on the relative value of these two feeds for producing milk. The price per ton will not tell this exactly even with these two feeds because there is less food in one than in the other. In one ton of gluten feed there are 1614 pounds of total digestible nutrients and in one ton of good cottonseed meal such as is on the market today, there are 1496 pounds of total digestible nutrients. Therefore if these two feeds both cost $66.00 per ton the advantage is with the gluten feed because we would get more total digestible nutrients for $1.00 in that feed. However, if one is looking for protein to supplement other feeds and the prime reason for buying the feed was to get the protein then he might wish to get the cottonseed meal because in buying a ton of cottonseed meal one gets 632 pounds of digestible crude protein while in buying a ton of gluten feed one gets only 432 pounds.

Therefore, one needs to study feeds carefully from two or three points of view.

1. From the point of view of the total digestible nutrients because these are the measure of the total food value of the particular feed in question. So long as there is enough protein in the ration one pound of digestible crude protein

is worth no more than a pound of digestible carbohydrates and only one half as valuable as a pound of digestible fat.

2. As a supplement to home grown feeds, roughage and grain, there is usually the question of an added protein supply. Under this condition the digestible crude protein has a value greater than its value simply as one of the total digestible nutrients. It is customary when one is buying a feed for the protein in it to compute the cost per pound of protein just as if other nutrients were valueless, and the purchase were made for the protein alone. In the example of the gluten feed and cottonseed meal at $66.00 per ton cited above the protein in the cottonseed meal would cost $66.00 per ton divided by 632 or about 10 cents per pound and the digestible protein in the gluten feed would cost $66.00 divided by 432 or about 15 cents per pound. Therefore, cottonseed meal is a cheaper source of protein than gluten feed if the thing sought is the protein alone. Both the cost of digestible nutrients and the cost of digestible protein must be considered however because rarely is a feed purchased for the digestible protein alone.

3. New ideas are coming up every day in regard to the value of feeds and it is no longer safe to look at a feed simply as a source of nutrients and protein. Feeds must be studied also as a source of different kinds of protein and as a source also of some illy defined substances about which we know but little but which are of great importance in the growth and well being of animals.

So much for an introduction. We will study the feeds available by plants, that is, we will take up one plant at a time and see what we get from it, how we get it and relatively what it is worth compared with other feeds.

THE CORN PLANT AND THE FEEDS IT FURNISHES

We naturally turn to the corn plant first for two reasons. First, one only has to watch the market for a short time to find the king of feeds. It has been said that cotton is king in the United States but I think that corn is the real king in this country from many standpoints, but particularly from a nutrition standpoint, both human and animal. When the supply of corn is big and it is running evenly, feeds are more reasonable in price except perhaps the high protein feeds. The demands for these to suppement the corn oftentimes drives them up above their normal as a source of total digestible nutrients because of their high value as sources

of protein. Second, studies at Wisconsin have established as for no other plant, the supremacy of the corn plant as food for animals. In this test at Wisconsin it was demonstrated that in rations using all parts of the corn plant animals can be completely nourished, will grow as they should and reproduce in a healthy, normal way. The wheat plant and the oat plant could not do this and lines of animals fed on rations made up from feeds whose only source was the wheat plant or the oat plant failed to survive. On a mixture of foods from the three plants the factor which made for normal growth was the corn, and growth and reproduction went on only in proportion to the amount of corn foods in the ration.

Therefore corn is the king source of dairy cattle feeds. We get from corn these foods:

ROUGHAGE

Corn silage
Corn fodder
Corn stover

CONCENTRATES

Corn meal
Hominy
Corn feed meal
Gluten feed
Gluten meal
Corn bran
Corn oil meal
Distillers' dried grains

We will take up first a brief study of the roughage feeds derived from corn. Many times has the value of corn silage been praised. Very little can be added. However, it is worth while again to make some comparisons. Its value as a source of succulence has been discussed. It is not a feed that furnishes protein cheaply. Therefore the value of corn silage lies in the amount of total digestible nutrients in it of the nature of carbohydrates to furnish large amounts of energy and to make the rest of the ration succulent and palatable.

In one ton of silage there are 354 pounds of total digestible nutrients. Eight dollars a ton is a reasonable price to pay for a ton of heavily eared silage. At this price per ton, one hundred pounds of total digestible nutrients cost $2.26 per hundred pounds. This compares favorably with the cost per hundred pounds of total digestible nutrients in concentrates at average prices. Eight dollars per ton for corn silage is high. Now generally speaking a pound of total digestible

nutrients is worth as much in corn silage as in any kind of food. Compared with clover hay at $24.00 per ton the value of 100 pounds of total digestible nutrients in silage at $8 is as $2.26 for the silage and $2.35 for the one hundred pounds of total digestible nutrients in the hay. In a ton of red clover hay there are 1018 pounds of total digestible nutrients. It is common practice to estimate the value of silage at one-third the value of hay. This price of $24.00 per ton for good clover hay is relatively no higher than is $8.00 per ton for corn silage. This shows how closely this practice is based on the principle that the food value in it is one-third the food value in the hay. However, a yield per acre to be comparable would require a yield of 3 1-3 tons of clover to 10 of corn silage. I think it will be agreed that we get 10 tons of silage per acre much oftener than we get 3 1-3 tons of good clover hay.

Average alfalfa hay yields 1032 pounds of total digestible nutrients per acre and on account of its high protein content and other exceptionally good qualities, coupled with the fact that we can get two crops per year, the comparison between corn silage and alfalfa is a very close one. Total digestible nutrients are as valuable in one as in the other. The best way to dispose of this comparison is to say that the ideal is to have both alfalfa hay and corn silage as the source of the principal feed in the ration.

This paper is a study of the source of feeds. I think enough has been said to show that with the one exception of alfalfa hay the corn plant as a whole preserved as in silage is the best source of feed that we have. The cost of 100 pounds of total digestible nutrients in corn silage, clover and alfalfa hay is about one half the average cost of 100 pounds of total digestible nutrients in concentrates. Therefore, one can easily see the saving there is in feeding when there is a good quality of roughage furnished as a source of feed with which to combine a good mixture of concentrates.

The other roughage products of the corn plant, corn fodder and corn stover, are valuable in their way only when one doesn't have a silo. A good Holstein breeder, however, needs a silo about as badly as he needs a pure bred bull. I think that most of the readers of the WORLD have pure bred bulls. Some of them, however, do not have silos. I hope those may see this article and see that a silo is as valuable nearly as the bull. Corn fodder is only a makeshift crop. According to the technical definition of the books corn fodder

is the entire corn plant harvested with the ears on, if there are any ears. It used to be grown sown broadcast, but few farmers would do that in modern times. A variety should be chosen that is reasonably sure to mature so that the grain and stover may be obtained. Immature corn fodder with half grown nubbins has practically no more value than corn stover from which the corn grain (ears) has been removed. Comparative analysis shows the total digestible nutrients in corn fodder to be 1074 per ton and in corn stover 932 per ton. Therefore, one should be sure to choose a variety suited to one's climate in order to grow all the grain in the plant possible and if the plant cannot be put into a silo pick off the best of the ears for husking and feed the rest as fodder.

Right here let it be urged that the field is no place to house corn stover. The more soluble digestible nutrients and much of the palatability of the plant is washed away by this treatment and this material washed out is of no use to the soil since it is largely carbohydrate in nature. Therefore, preserve the corn fodder under a roof as soon as it is cured enough so that it will not mold too badly in storage in order to have as much total digestible nutrients in the fodder as possible.

XXVI. Concentrates Derived from the Corn Plant

A KERNEL of corn is a most useful bit of food from either the human or animal point of view. A study of its analysis in comparison with other foods will show that it is low in mineral matter and low in fiber. The first must be overcome by proper combination with other foods in order that the proper mineral elements may be found in the ration. The fact that corn is low in fiber is a very useful thing in that this is one of the principal factors that gives corn its great value as a food for hogs. The upper limit of fiber in an ideal ration for hogs seems to be about 6 per cent. although hogs can handle a ration with 10 per cent. fiber but they will not do so well.

Corn is low in protein and the proteins need to be supplemented with feeds from other sources and of course corn grain must be supplemented by foods in the ration from the leafy portions of plants which are derived from the roughage parts of the ration. The palatability of corn and its great amount of easily digestible carbohydrates (starch) give it its high place among all of our grain feeds.

A MODERN CORN MILL

In milling the corn kernel is divided into the hard and soft starch, the bran and the germ. The process of corn milling gives us the following feed:

FEEDS FROM A MODERN CORN MILL

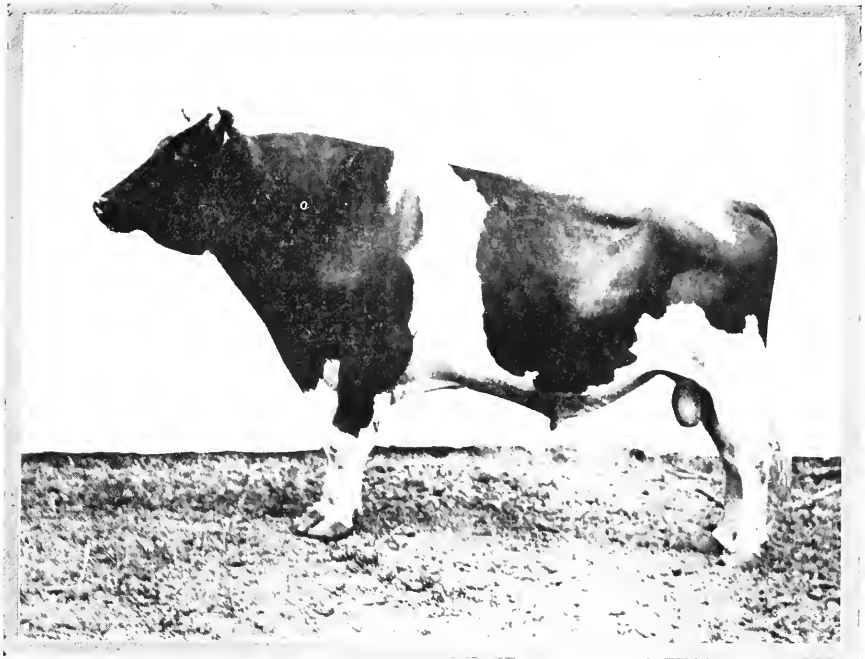
100 lbs. feed	Total Ash	Total Protein	Fiber	N-free Extract	Fat	Dig. Prot.	Total Dig. Nutrients
Corn meal	1.3	9.3	2.3	72.0	3.8	6.9	83.8
Corn and cob meal.....	1.5	8.5	7.9	67.6	4.1	6.1	78.1
Corn feed meal.....	2.6	10.6	4.4	64.3	8.0	7.0	84.6
Hominy feed	2.6	10.6	4.4	64.3	8.0	7.0	84.6
Corn germ oil meal....	2.7	22.6	9.0	46.0	10.8	16.5	82.5
Corn bran	2.4	9.7	9.8	62.4	5.7	5.8	73.1

In the modern milling of corn as compared with a few years ago one of the great differences is the recovery of corn oil. The corn miller cannot afford to grind his corn to cracked corn or corn meal for feed the way he did. He must recover this oil. Therefore, our modern corn mills are putting in machinery for degerminating the corn to get out the oil. The oil in corn is found principally in the germ. If the germs are entirely separated from the kernel it will be found that they are about fifty per cent. oil.

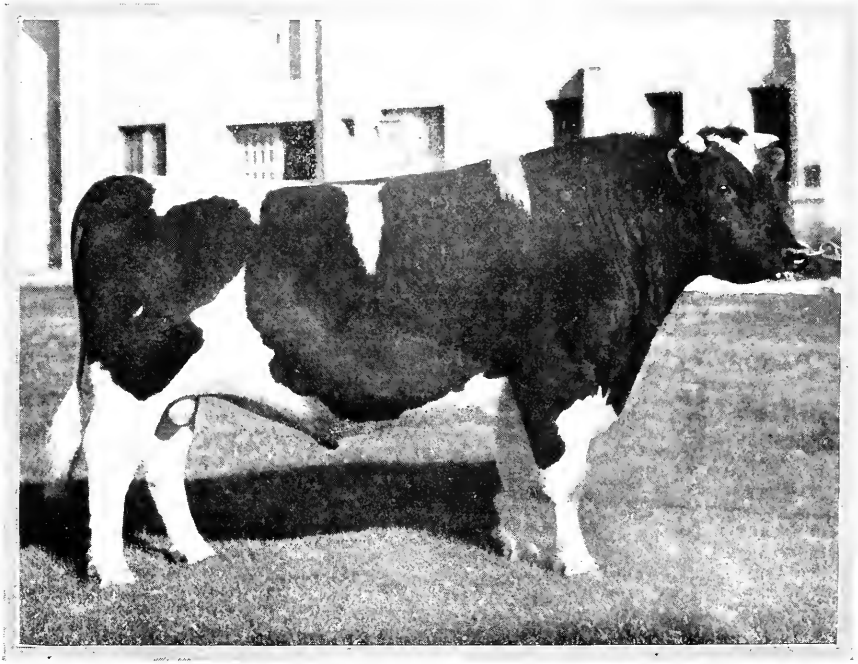
In the modern corn mill the degerminating process is not as complete as in the starch and glucose factories because the degerminating process that is used is practically dry and does not get out the germs so well. This wet process of degerminating corn will be described more fully when we come to discuss the manufacture of gluten feed.

Of course in modern milling a large amount of corn is made into straight cracked corn and corn meal for feeding. But for table meal, for grits and for poultry feed only the hard starch is desired and consequently the corn for these purposes is first degerminated and the germs used for the manufacture of oil.

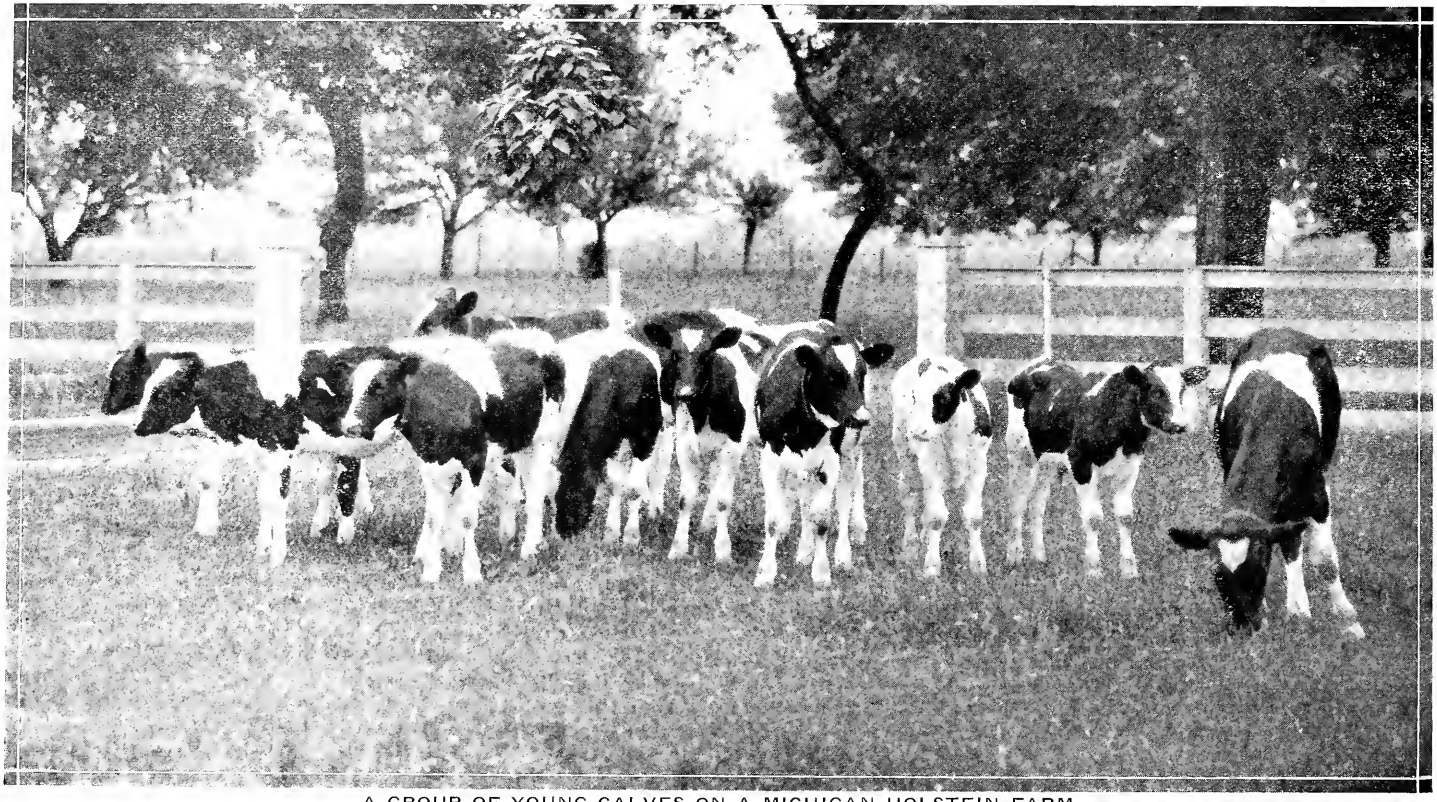
The corn to be degerminated is first tempered, that is, a small amount of water is added and steam turned into it which heats the corn up and brings the moisture content up to about 20 per cent. This tempered corn is then cracked by a special mill called a Beall Mill. This mill breaks the corn up in such a way that the germs come out by themselves to a large extent and may be separated for the oil presses. The soft starch can be separated out and the bran. The soft starch and the bran go to make a part of the hominy feed.



SIR PIETERTJE ORMSBY MERCEDES
One of the breed's greatest transmitting sires.



OAK DE KOL OLLIE HOMESTEAD
Grand champion, National Dairy Show 1916 and 1917.



A GROUP OF YOUNG CALVES ON A MICHIGAN HOLSTEIN FARM

The hard starchy portions of the kernels are used for different purposes. They may be polished up and all the fine stuff separated off and the finished shined material used for hominy grits. The waste goes into hominy feed. Or this shined material may be used in poultry feed or be reduced to a finer meal for human consumption. In any case the waste material separated out goes into hominy feed.

The corn germs go to rotary presses which take out the corn oil. The material left is called corn germ oil meal. This is ground and goes into the hominy feed.

HOMINY FEED

Thus it is seen that in the modern mill hominy feed arises from the (1) corn bran, (2) the soft starch portions of the corn kernel, (3) the waste from the screening, polishing and further grinding of the hard starch portion in the manufacture of fancy cracked corn, grits, table corn meal and all of these modern products, and (4) the residue of the germs after the oil is pressed out.

All of the by-products are ground up into the uniform product which we know as hominy feed. Hominy feed is mostly white because more white corn is milled for table products. Yellow hominy feed arises in the same way when yellow corn is milled. Modern hominy feed is a little poorer in feeding value than that of even a few years ago, because formerly the corn oil was not extracted from the germ and consequently hominy feed contained more fat than it does now. The analysis of hominy given in the table above is probably too high in fat. Hominy feed is one of the very best of our feeds as is shown in the table. It contains more protein than corn meal and the amount of total digestible nutrients is just a little greater than the amount of corn meal. It is lighter than corn meal and therefore more desirable for feeding dairy cattle. In all tests so far as the writer is aware, hominy feed has shown up as well as corn meal both for hogs and for cattle. It will keep better in storage; probably because it is somewhat drier and somewhat lighter. Hominy feed will store all right in bulk where it is not wise to store corn meal in this way. The official definition for hominy feed is as follows: "Hominy feed, hominy meal or hominy chops is the kiln-dried mixture of the mill run bran coating, the mill run germ, with or without a partial extraction of the oil and a part of the starchy portion of the white corn kernel obtained in the manufacture of hominy, hominy grits and corn meal by the degerminating process." The

official definition for yellow hominy feed is exactly the same as that for hominy feed except that it is made from yellow corn instead of white corn.

CORN FEED MEAL

The official definition for corn feed meal is as follows: "Corn feed meal is the by-product obtained in the manufacture of cracked corn with or without aspiration products added to the siftings and is also the by-product obtained in the manufacture of table meal from the whole grain by the non-degerminating process." By comparing this definition of corn feed meal with the definition of hominy feed given just above it will be noticed that there is practically no difference with the exception that corn feed meal would contain all of the germs without any of the oil having been taken out. Therefore, pound for pound it will be seen that corn feed meal should be somewhat more valuable for feeding than hominy. It will be noted in the table that I have given exactly the same analysis for corn feed meal and hominy feed. In the last edition of Henry's "Feeds and Feeding" there is no analysis given for corn feed meal. Corn feed meal is practically always yellow because it is in the main the by-product obtained in the manufacture of cracked corn and yellow table meal. Both hominy and corn feed meal in my estimation are better for feeding dairy cows than straight corn meal. The writer has also felt that the modern table meal that we buy in grocery stores is a very poor product for human consumption. Manufacturers have refined it to such an extent in order to make it look better that it has lost a great deal of the substance which makes the old fashioned water ground meal of greater nutritive value. What human beings have lost in the modern table meals our animals have gained in corn feed meal and hominy.

CORN BRAN

Corn bran is not found on the market to any great extent. As will be noted by consulting the table corn bran is an excellent light feed. It does not have as much digestible protein as wheat bran but the total digestible nutrients in one ton of corn bran are about 200 pounds greater than in wheat bran. Corn bran used in a ration having plenty of protein from other sources is a most excellent feed.

CORN GERM OIL MEAL

Very little corn germ oil meal appears on the market. Practically all of that corn germ meal which arises from corn mills which extract the oil from the germ in the ordinary mill-

ing process, run all of this corn germ meal into the hominy so that the only corn germ oil meal that we have on the market as such comes from the glucose process which is explained a little later. Mixed feed manufacturers know the value of corn germ oil meal, consequently in the eastern portion of the United States particularly it is carried by very few feed dealers. It is an excellent medium protein feed having fully the value of gluten feed, although it does not run quite so high in protein as gluten. Experiments at the Iowa Experiment Station have found it a very fine supplemental feed for hogs. It has been found there that corn germ oil meal can be used to save a part of the tankage which it has been thought necessary to feed with corn to supplement the corn.

Corn meal, corn and cob meal and cracked corn do not need any particular discussion. These are straight corn products of the corn kernel and all of us are very familiar with them already.

GLUTEN MEAL AND GLUTEN FEED

A very large amount of corn is ground up each year for the manufacture of starch and glucose sugar. In this case the corn is first steeped in a solution of water and sulphur dioxide. The wet corn is then ground up in a special mill called a Foos Mill which breaks up all of the corn kernel except the corn germ. This grinding puts the corn kernel into such condition that the corn germs are separated out in an unbroken condition. The germs are then dried, warmed and the oil pressed out of them. This leaves behind corn germ meal which is marketed as such from the glucose and starch manufacturing plants.

That part of the corn kernel that remains after the germ is taken out is subjected to several separations which yield corn bran, starch and gluten meal. The starch is refined into several different brands of commercial starch or the starch is changed into several different grades of sugar. The official definition for gluten meal is "Corn gluten meal is that part of commercial shelled corn that remains after the separation of the larger part of the starch, the germ and the bran, by the processes employed in the manufacture of cornstarch and glucose. It may or may not contain corn solubles." Some gluten meal is sold as such and if one will study the definition closely and will stop to realize what has happened to the corn kernel he will see what kind of a product is left in gluten meal. The corn bran is gone, most of the starch is

gone, the germs are gone, therefore, gluten meal must be very high in protein.

Gluten feed is gluten meal mixed with the corn bran and the material which is dried out from the "steep" water that the corn was originally steeped in before grinding. The official definition of gluten feed is "Corn gluten feed is that portion of commercial shelled corn that remains after the separation of the larger part of the starch and the germs by the processes employed in the manufacture of cornstarch and glucose. It may or may not contain corn solubles." In order to bring out the differences, the following analyses are given.

	Total Ash.	Total Protein	Fiber	N-free Extract	Fat	Dig. Protein	Total dig. Nutrients
Gluten meal	1.1	35.5	2.1	47.5	4.7	30.2	84.0
Gluten feed	2.1	25.4	7.1	52.9	3.8	21.6	80.7
Dis. dried grains	2.6	30.7	11.6	36.3	12.2	22.4	88.9

This table clearly shows how the addition of the corn bran to the gluten meal gives gluten feed. Comparison with the first table in the paper shows the differences between the corn milling processes and the glucose starch processes, and therefore, the difference between hominy feed and gluten feed. Gluten feed has more protein and less carbohydrates and less fat because in the practically dry milling of the corn mill more starch is left in the by-product but a great deal of the protein goes into the main products. More fat is found in the hominy feed because in the first place all of the germs are not separated out and in the second place the germ oil meal goes back into the hominy feed. In the wet processes which give rise to gluten feed a very large proportion of both the hard and soft starch goes into the main product but all of the gluten or protein is left behind in the by-product. None of the germ is left in the by-product consequently gluten feed is high in protein but only medium in carbohydrates and low in fat. However, so closely do these differences offset each other that the amount of total digestible nutrients in one ton of hominy, 1692 pounds, is only slightly larger than the amount of total digestible nutrients in one ton of gluten feed, 1614 pounds. The amount given for the hominy is probably too high because most of the analyses for hominy given in "Feeds and Feeding," from which these analyses are quoted, are for hominy containing

all the germ without the extraction of the oil. Gluten feed is one of the very finest of the high protein feeds just as hominy is the ideal low protein feed for milk production.

DISTILLERS' DRIED GRAINS

This feed is practically gone. Dairymen will gain from prohibition particularly if they all hold together and boom milk as the great natural health drink but they have lost one of the best high protein feeds. Little space will be taken here for discussion of distillers' dried grains but it is of interest to mention them because of the principles in their manufacture. In manufacturing alcohol from corn nothing is taken out except the starch so that in distillers' grains we have left the corn bran, the gluten or protein, and all the germ. Therefore, distillers' dried grains from corn are high in protein, low in carbohydrates and high in fat. The large amount of fat left in them causes them to run high in total digestible nutrients. The starch is so much more completely separated out in the process of distilling that the protein runs higher than in gluten feed and the fiber is also somewhat higher. A thorough fundamental understanding of every feed can be had if we stop to think of the analysis and makeup of the original cereal with which we start and then think out what part is taken out in the manufacturing process and what parts are left in the by-products.

A NEW BY-PRODUCT FROM CORN

Maltose syrup or sugar is being manufactured from corn. As I understand the process, although I have not visited a factory as yet, the germs will all be left in this case and nothing but starch taken from the corn kernel. If this is the correct understanding then the by-product from maltose manufacture will closely resemble distillers' grains from corn. I have seen a sample of this by-product and it resembles distillers' grains quite closely.

Distillers' grains have one quality which gluten lacks; namely, a fine mechanical bulky condition. This new corn maltose by-product has that good quality of bulkiness. Gluten manufacturers might well try to turn out gluten feed in this bulky condition.

This completes the discussion of the feeds derived from the corn plant. It is the greatest plant friend of the dairy farmer and I hope this description may help others to understand just a little better some of the products we get from corn.

XXVII. Barley and Its Products

FARMERS have a very favorable crop in barley. I sometimes think that its value as compared with corn for feeding purposes is not realized so well in this country as it is in the old countries. Probably this is true because corn grows so easily and under ordinary circumstances the difference between the price of barley and the price of corn is not great. When there is a difference in price considerable money can be saved in feeding if one has taken advantage of the barley market.

In feeding pigs ground barley is particularly valuable. It is a close competitor of corn. One experiment at the Wisconsin Experiment Station in the past year or two has shown that ground barley and whey appear to supplement each other exceedingly well in the growing and fattening of pigs. While we are thinking of barley particularly as a food for dairy cattle yet it is worth while to call attention to its value for other animals as well as for the cow in milk.

Ground or rolled barley is a very valuable feed for horses and it can be made one of the ingredients of a very successful growing ration. As a mixture it would be hard to beat equal parts of ground barley, ground oats and corn meal with 10 per cent. by weight of oil meal to put good healthy growth on calves.

In regard to its value for dairy cattle an interesting trial at the Wisconsin Agricultural Experiment Station may be reported here. Two groups of six cows each averaging about 1000 pounds in live weight were fed for two periods of six weeks each. Sixty per cent. of the grain mixture fed to the first lot during the first period was ground barley. At the same time the second lot was getting a grain mixture, sixty per cent. of which was ground corn. The ingredients of the rations were otherwise the same. At the end of the first six weeks period the rations were reversed, the first lot getting the corn ration and the second lot the ration containing the barley. The rate of feed was one pound of grain daily for every pound of butterfat produced in a week by each cow. All the cows were fed alfalfa hay and corn silage for roughage. The proportion of silage to hay was three pounds of corn silage to one pound of alfalfa hay fed daily for every 100 pounds of live weight.

The ground barley mixture was made up of 600 pounds of ground barley, 150 pounds of wheat bran, 100 pounds of

brewers' dried grains, 75 pounds of cottonseed meal and 75 pounds of linseed oil meal. In the second mixture corn meal was put in place of the barley in the same proportion. The average daily ration eaten by the cows in both groups was 9.07 pounds of hay, 31 pounds of silage and 7.4 pounds of grain. The same average amount was fed to all cows irrespective of whether they were getting ground barley or the corn meal. The cows fed the barley ration did not do quite so well as the cows fed on the ration containing the corn meal, but there is so little difference between the yields of the two groups that it is not possible definitely to say that the corn meal was superior to the barley as an ingredient of a good milk ration. Both groups averaged about 25 pounds of milk, testing 3.6 per cent. butterfat.

There was some difference in live weight which was in favor of the barley ration. During the time that they were fed those cows which received the sixty per cent. barley grain mixture apparently gained 1.9 pounds per head. Those cows that were fed on the grain mixture containing sixty per cent. of corn meal apparently lost 1.6 pounds per head per day while being so fed. However, these differences in live weight like the milk and fat production are too small to be given very much consideration as proving the barley to be of greater value than the corn meal. This much can be said, it seems to me that the rations were practically equal in value and from the results of this test we must conclude that the ground barley was fully as effective as the corn meal in a ration for milk production.

I feel that this test and the tests that are somewhat older but which point to the same results show that barley is a very good feed. Now that we have national prohibition in the United States, it seems to me that there should be a greater quantity of barley available for feed.

THE BY-PRODUCTS FROM BARLEY—MALT SPROUTS, BREWERS' DRIED GRAINS

Naturally barley is a low protein feed in the same class with the other cereal grains such as wheat, rye, corn and oats. In the process of malting and brewing, the substance which is needed for the production of alcohol is the starch of the barley grain, the same as in each case where alcohol is produced from vegetable material. Consequently the carbohydrates are used up for the production of alcohol and the proportion of protein in the residue is larger. There-

fore, we would expect to find brewers' dried grains and malt sprouts to be feeds high protein in nature. This is exactly what we do find.

Briefly the process of the manufacture of beer from barley is as follows: The first stage of manufacture is the malting. The barley is moistened and put into a warm room on the floor in a layer a few inches thick. The moisture and the warmth causes the barley to sprout. The sprouts are allowed to grow until the experience of the malster tells him that all of the starch in the barley grain has been transformed into malt sugar. This takes a number of days. The sprouted barley is then kiln-dried and run over screens which take out all the dirt and break off the small sprouts. The screened barley is the commercial product which we know as malt and practically all of the starch in this barley grain has been converted into maltose sugar. In the process of screening the malt sprouts are all broken off and this gives us the commercial feed that we know as malt sprouts.

The malt is then brewed which takes out the malt sugar and this is used in the manufacture of beer. This process of manufacture leaves as a residue of the barley kernel, the ash, the protein and the fiber and the fat. There is also considerable carbohydrate matter which was not transformed in the process of malting. This residue is kiln-dried and comes on the market as brewers' dried grains, a high protein feed having a great deal of value.

THE FEEDING VALUE OF MALT SPROUTS

Malt sprouts contain 26.4 per cent. protein. Therefore, they rank as a high protein feed. In 100 pounds of malt sprouts there are 20.3 pounds of digestible crude protein and in one ton of malt sprouts we have 1412 pounds of total digestible nutrients. On the basis of total digestible nutrients malt sprouts would have in them somewhat more digestible material than wheat bran and about the same amount as in ground oats. Besides malt sprouts are high in protein and will help in a ration in which there is a necessity for protein. This protein in malt sprouts is, however, not so valuable as the protein found in other grains.

Malt sprouts having been dried in a kiln and because of their nature absorb water very rapidly. Therefore, if one is going to put into his ration more than two or three pounds of malt sprouts per day, he is likely to have digestive troubles with his cows unless the malt sprouts are soaked before feeding. A very good way to use malt sprouts is to soak

them up with water and feed the rest of the grain dry on top of the malt sprouts. Three or four pounds of soaked malt sprouts per day per animal makes a very valuable succulent feed in case one does not have silage. Personally I have not liked malt sprouts very well as a dairy feed, but there is no reason why they should not be very valuable when properly used.

THE FEEDING VALUE OF BREWERS' DRIED GRAINS

Brewers' dried grains in my opinion are more valuable pound for pound in dairy rations than wheat bran or ground oats. They are particularly valuable because of the high protein which they contain. There is in 100 pounds of brewers' dried grains a total of 26.5 pounds of protein, of this 21.5 pounds are digestible. In one ton of brewers' dried grains there are 1314 pounds of total digestile nutrients, a little less in value according to computation than in one ton of malt sprouts. In my opinion pound for pound brewers' dried grains are more valuable than malt sprouts. Here again I have had some personal idea that I would not like brewers' dried grains very well as a dairy feed, but then the price is such as to warrant their use. I know that brewers' dried grains are more valuable than oats but they are less valuable than the other high protein feeds such as gluten feed, oil meal and cottonseed meal. I look upon brewers' dried grains as a very valuable feed for adding bulk to a ration otherwise too heavy.

BARLEY FEED

During the war some barley was used for the manufacture of barley flour for human consumption. As I remember it millers took out about 45 per cent. flour leaving 55 per cent. of the barley kernel in the form of what was known commercially as barley feed. Good brands of barley feed made up of 50 per cent. of the kernel would be more valuable it seems to me than wheat mixed feed and if I had an opportunity to buy barley feed as cheaply as I could buy wheat feed, I would choose the barley feed because I think that the percentage of the nutrients would be greater than in the wheat feed.

XXVIII. Rye and Oats and Their Products

IN THE rye crop we have a crop which will give us the earliest green feed in the spring. Rye seeded in September and October in the climate of southern New York and northern Pennsylvania will give a cutting of green feed surely by the 15th of May. No other crop will do as well as

this. Rye is often used as a winter cover crop because a good amount of green material may be turned in from this crop earlier in the spring than with any other, so that rye makes an excellent soiling crop or crop for green manure.

The green rye crop may be used as early pasture for hogs or for cattle. This green feed is practically the only way that rye can be utilized as a roughage due to the toughness of the green rye straw. The rye plant is rarely used for hay. The same applies to rye straw from which the grain has been thrashed. The straw is so tough that it is not palatable and cannot be used to good advantage by the animals. Therefore, we must put the rye plant down as one of the poorest plants that we have for production of roughage except for its usefulness as a very early green crop to be used as a soiling crop or for pasture in the spring.

RYE GRAIN

Rye has been used as a grain probably as widely as any plant that we have. It is known in all countries and is a good crop because it will grow on many different soils. This grain, sometimes called "Grain of poverty," thrives in general in cool regions. It is said that one-third of the people of Europe obtain their bread from rye. Rye is fed commonly to all animals all over Europe and Asia. It is not so well known in America and due to the fact that it is not well known many farmers have aversion to it for feeding. I think that the dangers from feeding rye to animals is over estimated.

As a feed for dairy cows ground rye may be used in rations just as one would use ground oats or ground barley or corn meal, that is, to form a part of the grain mixture with proper bulky feeds like wheat bran or ground oats and proper high protein feeds like gluten feed, oil meal or cottonseed meal. Probably it is not advisable to grow rye for feeding dairy cattle unless there is something about the soil on a given farm which seems to demand the use of the rye in the rotation. I doubt if ground rye is as valuable as ground barley or corn meal for dairy production, but a good dairy farmer should always be on the lookout for a bargain in a grain, and if it is possible to purchase rye relatively cheaper, it will be found to be a valuable addition to the grain mixture.

In comparison, ground rye does not differ materially from ground barley. According to average analyses ground rye would contain 1620 pounds of total digestible nutrients per ton. A ton of ground barley would have in it 1588 pounds

of total digestible nutrients. Compared with corn the rye is less valuable. A ton of corn meal will have approximately 1676 pounds of total digestible nutrients. Therefore, on the basis of digestibility as shown by the number of pounds of digestible nutrients, rye would come about half way between ground barley and corn meal.

There is some prejudice against the feeding of rye to horses in this country. It is possible that many of the bad results laid to rye is due to grain of poor quality or grain containing impurities. To be perfectly safe it seems to be well to avoid the feeding of rye in large quantities to horses. From what data we have it seems probable that ground rye ranks about the same as ground barley as a suitable food for the production of pork.

RYE WILL NOT PRODUCE ABORTION

One of the things attributed to rye for which I think it is not to blame is the accusation that rye used as a feed for dairy cattle will cause abortion. I think that this is not in any way to be proven by any evidence that I have ever seen. I think that no dairy farmer who has an opportunity to buy rye at a good price should hesitate to use it for his dairy because I do not think that it is possible to produce abortion in cattle in this way.

RYE BY-PRODUCTS

The by-products in the manufacture of rye flour, are rye bran and rye middlings. These by-products are not usually sold separately, but are combined and sold as rye feed. Rye feed according to analysis has in it about 15.3 per cent. total protein as compared with 16.8 per cent. total protein in wheat feed. One ton of rye feed will contain about 1490 pounds of total digestible nutrients where one ton of wheat feed will contain about 1340 pounds of total digestible nutrients to the ton. The comparison of these two analyses shows that rye feed will carry somewhat less protein than wheat feed but that there are more total digestible nutrients per ton in the rye feed, making the rye feed somewhat more valuable than wheat feed as an ingredient in a grain mixture carrying plenty of protein from other sources. I should feel that where it is possible to buy rye feed that it would be found to be fully as valuable as wheat feed and can be used in the grain mixture in the same way.

OATS

When we come to this feed we come to a feed which is used possibly as widely as any feed with which farmers have to do. Oats are grown the whole country over by large and small, and rich and poor farmers. It comes pretty nearly being the universal feed for horses in the United States.

As a roughage oats are utilized both as green feed, as hay and the straw is probably the most useful straw for feeding of any of the straws from the cereal grains. Oats grown with Canadian field peas make one of the very best of our soiling crops and a useful crop in that the seeding time and harvesting time may be spread over a considerable number of days by making successive plantings and in this way securing a succession of green crops through the early summer. Oats and peas both have the advantage of getting started early in the cool spring months and thus making it possible to get a green crop rather early in the year from a spring seeding of the same year.

Oats cut in the milk stage make a satisfactory hay.

Oat straw according to its analysis has nearly as high a value for feeding as straight timothy hay. I very much doubt if horses could utilize oat straw to anywhere near as good advantage and get as much out of it as they could from timothy hay, but if one is forced to the feeding of timothy hay to dairy cattle, particularly if the timothy hay is late cut, I am of the opinion that he would make more money if he would utilize oat straw to considerable extent, to supply the necessary roughage and sell the timothy hay, because timothy is not utilized to good advantage by dairy cattle and straight timothy is not much more palatable than oat straw.

However, I do not think that we need to use up any valuable space discussing the feeding value of any kind of straw before an intelligent audience of dairy farmers, because no farmer who is on to his job is going to force his cows to eat either timothy hay or straw of any kind for roughage. The only decent roughage for a dairy cow and the only kind that her owner should ever put before her is a good variety of legume hay. The place for straw in a real dairy barn is not before the cows but under them.

OATS AS A GRAIN FEED

Oats used as a grain makes up one of the most useful feeds that we have on the dairy farm. We do not need to discuss the value of oats for horses. Almost all people,

farmers and others as well, look upon oats as a natural grain feed for horses.

One of the best uses which can be made of oats on a dairy farm is as an ingredient of the growing ration. The writer has found very useful as a mixture for growing young stock of all ages the following:

30 pounds ground oats or rolled oats
30 pounds wheat bran
30 pounds hominy or corn meal
10 pounds oil meal

I have always liked rolled oats better than ground oats and I think there is a real danger in having oats ground too finely. The writer has had indirect experience with the feeding of a car of heavy oats ground very finely, so finely that at a distance away a bin of these finely ground oats could hardly be distinguished from a bin of hominy feed from white corn. In every case where these finely ground oats were fed to dairy cows or to calves the animals would scour and while it is hard to believe that the ground oats would cause this trouble yet when these finely ground oats were taken out of the ration this trouble disappeared. To be sure this is only a single instance but it seems to the writer that rolled oats would be more palatable and would serve every purpose for which ground oats could be used and on a whole would be more advantageous and more palatable to most animals.

Once or twice I have taken occasion to make a rough survey of a number of the feeders of many advanced registry animals with creditable records. In practically every case I have found that ground oats with wheat bran and oil meal makes up the fitting ration, not always the combination given above for growing stock but of approximately that combination. Most of the men fitting their animals for advanced registry records seem to prefer a little larger proportion of oil meal. Several cows have made 30-pound records to the knowledge of the writer who have had the above mixture of the equal parts of oats, wheat bran and hominy with 10 pounds of oil meal used as the sole mixture fed when cows were dry.

A grain mixture composed of rolled oats alone does not make up a bad mixture for young calves and growing stock. If rolled oats and milk are good for children and babies, rolled oats and milk should make an excellent ration for growing milk-producing animals.

Ground oats is a very favorite feed in the rations of those

who are making creditable advanced registry records. Rolled oats is particularly valuable as a bulky feed to supplement wheat bran in rations nowadays when we no longer have distillers' dried grains to add the bulk that we want in our best dairy feeds. Dairy farmers will do well to see to it that they have a good acreage of their land devoted to the raising of oats for their young stock and to put into the dairy ration.

BY-PRODUCTS OF OATS

Rolled oats is without question one of the best known of our breakfast foods and is used universally by all classes of people. This of course has given rise to a great industry in the milling of oats and since only the groats are used for this purpose there arises from the oat meal mill thousands of tons of what is known as oat meal mill by-product.

In the process of the manufacture of oat meal, to describe it in a brief way, the oats are first dried or tempered. so that the hull can be readily separated from the groat, the oats are then milled to separate the hulls from the groat. In the process of milling there necessarily is an amount of middlings and what might be called oat bran separated from the oat groat as well as the hull. Therefore, the oat meal mill by-product is made up of oat hulls, oat middlings, oat bran and oat dust. These are all mixed together and sold as oat meal mill by-product. It takes 320 pounds of oats to make 200 pounds of oat meal. Therefore, about one-third of the oat is hull and there would be a yield of oat meal mill by-product from any given mill of about one-third of the total oats used in the manufacture of oat meal, thus it can be readily seen that there is an enormous quantity of this by-product manufactured every year.

This material is reground and sold in the market as oat feed. Most of it is sold as an ingredient of mixed feeds. The amount of total digestible nutrients in one ton of oat feed is about 1100 lbs. In my opinion this is a very liberal rating of digestibility. The amount of digestible protein is not over 7 per cent. For comparison, wheat bran has 1218 pounds of total digestible nutrients per ton and red clover hay has 1018. Therefore, it will be seen that oat feed has a value not much, if any, above that of roughage.

In mixed feed manufacturing oat feed is used to give bulkiness to a feed that would otherwise be too heavy. There has been little demand for this feed as such and oat feed is not generally on the market as a separate ingredient.

Farmers as a rule do not care for it and feed dealers do not find it profitable to stock it.

BARLEY, OATS AND PEAS

We have discussed the feeding of barley and in this paper we have said something about the usefulness of oats. It seems to the writer that this is the proper place to just say a word about the use of Canadian field peas. Field peas analyze 22.9 per cent. protein and are highly digestible. One ton of field peas yields 1524 pounds of total digestible nutrients.

One of the very best home grown grain mixtures would be a mixture of barley, oats and peas. A good seeding mixture is 7 pecks of oats, 3 pecks of barley and 1 peck of peas. This mixture has given good success in New York State and I know of one farmer who harvested this year 1500 bushels of this home grown grain. I just want the readers of the HOLSTEIN-FRIESIAN WORLD to think about how this man is fixed with a herd of 50 purebred cattle and attendant young stock, who to my knowledge has in his barn a good supply of alfalfa hay, a couple of silos full of good corn silage and 1500 bushels of barley, oats and peas as a starter on his ration for the coming winter. I rather think that he is not worrying very much about car shortage, the high price of feed and things of that kind. The only thing that concerns him is to see to it that the Dairymen's League gets him a good price for his milk, and as a fitting end to this short article on the merits of rye and oats, I take pleasure in calling attention to this example as the highest type of home grown ration that I have come across in my experience.

XXIX. Wheat and Its By-Products

CORN is always king in America from the cattle feeders' standpoint. On account of the offal produced from milling, wheat runs a close second because of the immense amount of the by-product produced which is first class material for feeding animals. The principal by-product of wheat, the bran, is of particular importance to feeders of dairy cattle because of the bulk it gives to the ration as well as because of the nutrient present. All of the by-products of wheat are of particular importance this year because they are relatively cheaper. This is to me emphasized more and more as the year goes on because oats, practically the only other source of bulk in the dairy cow mixture, are going to

be scarcer and scarcer as the feeding season advances. First let us look into the value of wheat as a roughage, then examine the value of wheat itself as a food for animals and lastly study the by-products.

WHEAT AS A GREEN CROP

The wheat plant does not stand very high as a source of feed in the form of roughage. In only one place does it stand out. As a soiling crop it is early in the spring. Only one other crop can be cut earlier and that is rye. For the few farmers who depend wholly on soiling crops with no pasture a small acreage of wheat will give them a green crop for use early in the spring following rye. This crop of wheat will fit in well and help out with alfalfa and clover to get a succession of soiling crops up to the time when the first crop of peas and oats is ready. It has the further advantage of being a crop that has a value for grain if it is not all used up as a soiling crop.

WHEAT AS A FEED

Ordinarily wheat is too valuable to be fed as a grain in the same sense that one feeds corn or oats or barley. If, however, for any reason the wheat is unfit for milling or if one can buy a lot of wheat reasonably it has an excellent feeding value when ground and mixed with other feeds for a ration. In this respect it is probably fully equal to corn or barley for feeding dairy cows or other animals. Ground wheat is not so palatable as corn or oats or barley because when ground up it forms a sticky mass in the mouth.

Salvage wheat is the name given to wheat that has been damaged by fire or water in elevator fires or wheat that has been damaged in the holds of ships when transported by water. This salvage wheat is nearly as valuable for feeding as the best of wheat and sometimes very good bargains in it may be had by farmers who are alert in buying in the larger cities where there are grain elevators. Wheat is particularly valuable for poultry.

An experiment carried on at the Wisconsin Experiment Station has demonstrated that animals cannot be grown in a satisfactory manner on the products of the wheat plant alone. A group of cows was fed on wheat straw and a grain ration made up of wheat and its by-products. Another group was fed on a ration made up entirely from the oat plant and another on a ration made up entirely from the corn plant, and a fourth group was fed on a ration made up from feeds selected from all three plants, corn, wheat and oats.

The group fed on the ration from the wheat plant did the poorest of all. Therefore this teaches us that wheat feeds must be supplemented with feeds from other sources.

It is probably not worth while to try to make use of wheat straw in feeding any kind of animal.

THE MILLING OF WHEAT

The main reason wheat is grown is to furnish flour for human consumption. Wheat could not be grown economically as a feed for animals when there are plants such as corn, oats and barley that can be grown to furnish feed. People over the world demand white bread, consequently a great industry has been built up which furnishes white flour for this purpose and we get the offal for feeding animals.

It takes about 274 pounds of wheat, four and one-half bushels, to make a barrel, 196 pounds, of white flour. That leaves us approximately 78 pounds of offal for animal feed. This is about 71 per cent. extraction as it is called. During the war this extraction was raised to about 73 per cent. which decreased the amount of by-product available for feeding during that time. The consumption of wheat in the United States is about four and one-half bushels of wheat per person per year, to say nothing of the flour that is milled in this country and exported leaving the offal here. This shows what an enormous quantity of wheat by-product there is for our animals and what a factor it is in the feed supply.

The offal or by-products from the milling of wheat consists of wheat bran, standard wheat middlings, flour wheat middlings, red dog flour, and low grade flour. The process in brief is this. The wheat is not ground but is run through rolls that break it. There are several of these pairs of rolls, the rolls of each pair being somewhat closer together than the pair preceding. After the wheat passes through each pair some of the flour is taken out. Thus the manufacture of wheat flour is a gradual reduction process until all of the flour has finally been separated from the bran and middlings. In war time not quite so close a separation of flour was allowed, consequently "war grade" flour contained all the red dog and low grade feeding flour and a higher percentage of the wheat was thus utilized for human consumption. Patent flour means flour from which all possible by-products have been separated and is the highest grade of white flour made.

WHEAT BRAN

Wheat bran is the commonest of the wheat by-products and is the most bulky and coarse. It should be flaky and sweet. The bran is made up of the three outer coatings of the wheat berry and is comparatively rich in digestible protein, carries considerable digestible carbohydrates and fat and is not very high in fiber. Wheat bran weighs about one-half a pound to the quart and because of this bulkiness and its high feeding value it is one of the finest dairy feeds that we have. Some years ago the writer had one of his students write to the feeders of the forty highest record cows in all four dairy breeds and ask them for the feeds in their rations. Twenty-two persons answered. The only feed used in the ration by all twenty-two feeders was wheat bran. This shows that wheat bran is the universal dairy feed liked by all the advanced registry men as well as the plain every day feeders of the land.

Wheat bran is mildly laxative due to a phosphorous compound in it and not entirely to its bulky nature as is thought by most persons. This quality adds much to its great value as a feed. This laxative quality makes it a very desirable feed for convalescing animals when fed as a hot mash prepared with hot water. Bran is one of those feeds that is neither a roughage nor a concentrate. It is generally classed as a concentrate but like a roughage an animal can gorge herself on wheat bran and suffer no ill effects. Therefore it can be used in any quantity in a ration but because of its bulk and because it is not as highly digestible as other concentrates, if for no other reason, it cannot with profit be made the sole grain fed. It finds its greatest usefulness as an ingredient of a mixture composed of about four or five feeds in all.

Wheat bran lacks lime although it is high in phosphorous. Therefore it makes an ideal feed to be fed in a good grain mixture with alfalfa or clover hay which have the lime the bran lacks. Good legume roughage with heavily eared corn silage and a good supply of bran form a fine foundation for any ration.

Bran is particularly fine in a ration for growing animals with legume hay. For years my standard mixture for growing animals has been; 30 pounds wheat bran, 30 pounds ground oats, 30 pounds hominy or corn meal, 10 pounds oil meal, with legume hay and corn silage. So fine a growing combination is wheat bran and alfalfa hay that I once heard

Joseph E. Wing say that such a ration when fed to pregnant ewes caused the unborn lambs to grow such large bone that the ewes had trouble at lambing time in giving birth to such large lambs.

A good bran should analyze 16 per cent. protein, 4.4 per cent. fat, 53.7 per cent. carbohydrates other than fiber, and not to exceed 9.5 per cent. fiber, and should contain at least 1218 pounds of total digestible nutrients per ton. These figures are the average of the analyses of 7,742 samples. Therefore one should always find out the analysis of his bran particularly if it contains screenings and check up and see if it is up to the average standard.

Bran from local country mills is likely to be fresher and more palatable than bran from large western mills because it has not been milled so long and because it is likely that more flour is sticking to it because it may not be so closely milled.

WHEAT FEED, MIDDLINGS AND RED DOG

What has been said of bran applies to wheat mixed feed. Wheat feed is supposed to be the mill run of all the wheat by-products mixed together in the same proportion as they come from the wheat. Because the other finer by-products are mixed with the bran mixed feed contains more digestible matter per ton and is therefore a more valuable feed than bran. It can be used in the ration anywhere that bran can be used.

As we go down in fineness through the different grades of middlings to red dog and low grade flours the amount of digestible nutrients per ton increases and with this the feeding value but there is a loss in palatability and bulkiness. But all of these feeds can be used to good advantage in the dairy ration if combined properly with other concentrates.

The middlings have a very high value for feeding hogs to supplement corn. One of the best hog men in the middle west uses middlings to supplement alfalfa for a growing ration for pregnant sows and growing pigs in the same way as suggested above in the use of bran with alfalfa for growing young cattle. His mixture to be fed with skimmed milk is made of 56 pounds corn meal, 48 pounds ground barley, 32 pounds ground oats, 136 pounds flour middlings, 50 pounds alfalfa meal.

In summer on pasture the alfalfa meal is cut out of the mixture. Thus it is seen that middlings are considered a

good protein supplement with corn, barley, oats and alfalfa in a growing ration.

SCREENINGS

In cleaning up wheat for milling a large amount of by-product called screenings is secured. This may have considerable value for feeding if it contains a large amount of broken wheat and valuable weed seeds. Screenings are variable however, on account of the dirt and chaff that they contain. They should always be thoroughly ground before feeding in order to destroy all weed seeds and make sure that they will not get back on the land through the cow.

In order to get rid of the screenings to good advantage millers have adopted the practice of grinding these screenings and mixing them with the bran or middlings and selling the product as "wheat bran with screenings not exceeding mill run" or "wheat bran with mill run of screenings". This means that ground screenings in quantity not exceeding that in the wheat from which the bran is derived, have been mixed with the bran. The same applies to mixtures of wheat middlings and screenings. Bran or other wheat by-product mixed with screenings is subject to state license and inspection in most states and one should always know the analysis of the wheat by-product that he is buying and see that it is up to the standard.

All things considered the wheat plant gives us a wonderful series of foods valuable to us as humans both as food directly and indirectly as food to us through our animals.

XXX. Buckwheat and Its By-Products. Rice and Its By-Products. Sorghums and Millets

IN PREVIOUS articles all of the common cereals and their main by-products used for feeding dairy cows and dry stock have been discussed. There are some plants more or less resembling cereals or used like them that should have some discussion in this series of papers on the "Sources of Feeds". The first of these common feeds is buckwheat.

BUCKWHEAT AND ITS PRODUCTS

The buckwheat plant is not as useful as a plant to be pastured or as a green soiling crop. Its whole use is through the grain that it bears. From the fact that buckwheat will produce a good crop on relatively poor land it is grown on parts of farms that otherwise would not produce much grain.

Buckwheat is useful as a grain for dairy cows and young stock when ground but the buckwheat shucks or hulls have no feeding value so that compared with the cereals, oats, barley and corn, ground buckwheat is much less valuable. It is a case of the valuable part of the seed being diluted with a worthless part so that the whole is rather low. To reduce the value to comparative terms I would say that ground buckwheat is probably a little more valuable than wheat bran and less valuable than ground oats for feeding cows. The number of pounds of total digestible nutrients in one ton of ground buckwheat is 1268, compared with 1218 pounds in a ton of wheat bran and 1400 pounds in a ton of ground oats. There is more protein in the bran so that possibly the wheat bran is just as valuable as the ground buckwheat pound for pound when we consider the extra protein in the bran. Ground buckwheat is 10.8 per cent. protein, 8.1 per cent. digestible, and wheat bran is about 16 per cent. protein, 12.5 per cent. digestible. So we can see that the use of bran in place of ground buckwheat would increase the protein in the grain mixture and add more bulk to the mixture than the ground buckwheat. Therefore, it has been my suggestion to farmers having buckwheat to grind, that they sell the buckwheat and buy wheat bran whenever they can make the exchange at the same price. They have to go to town to get the buckwheat ground at a cost of 15 to 20 cents a hundred so that at the same price per ton the exchange is in favor of the wheat bran.

BUCKWHEAT HULLS

Before going into a discussion of the by-products of buckwheat I think it will be well to get a clear understanding of the comparative feeding value of buckwheat hulls. The quickest way to get this is to make a comparison to wheat straw. No dairyman would think of feeding wheat straw.

	Wheat Straw	Buckwheat Hulls
Crude protein	3.1%	4.4%
Fiber	37.4	43.7
Nitrogen free extract	44.4	38.5
Fat	1.5	1.0

When we study the digestible analysis we see an even less comparative value for the hulls.

	Wheat Straw	Buckwheat Hulls
Digestible protein	0.7%	0.4%
Digestible carbohydrates	35.1	13.9
Digestible fat	0.5	0.7
Total digestible nutrients in one ton	738 lbs.	318 lbs.

Therefore it is seen that ground wheat straw would be twice as good to mix with buckwheat middlings to lighten

them up as wheat straw. This shows conclusively that the hulls are not worth drawing home.

BUCKWHEAT FEED

Buckwheat feed is a mixture of buckwheat hulls and buckwheat middlings and is valuable in proportion to the amount of middlings which it contains. A buckwheat feed is subject to the feed inspection law and must be licensed in New York State and should be subject to the same law in any state as any manufactured feed. In many places small millers are selling the buckwheat feed without license and without guaranteeing the analysis or naming the ingredients. Mixing in such worthless hulls with the middlings is bad practice. The only way for farmers to combat it is to refuse the feed and demand the clear middlings unmixed with the hulls. Sometimes mixing of the hulls is somewhat covered up by regrinding the hulls so as to deceive the purchaser as to the amount of hulls present in the feed.

BUCKWHEAT MIDDLINGS

There is no feed much better for milk production than good buckwheat middlings unmixed and undiluted with hulls. The amount of digestible protein in buckwheat middlings is about 24 per cent. as compared with 21.6 per cent. in gluten feed. The total digestible nutrients in one ton of buckwheat middlings is 1532 and in gluten feed 1614, so it is seen that the buckwheat middlings are well up to the value of gluten feed. When made in a good local mill the value is likely to be fully as high if not higher than these figures represent.

A study of the analyses of buckwheat feeds as given in the last Geneva Experiment Station bulletin on Feed Inspection shows a tremendous variation in the composition of buckwheat feed. One guarantee is as low as 5 per cent. protein whereas on the other end of the variation we find a feed guaranteeing 20 per cent. protein. Others guaranteed 18 per cent. with one or two at 10 per cent. Good straight middlings apparently run about 30 per cent. total protein. It seems to me that the best practice for millers is to throw the shucks away and sell good straight buckwheat middlings.

RICE AND ITS BY-PRODUCTS

Of course very little rice will ever be used as such for animal food because of its great value as a human food, but there seems to be some rice bran and rice polish on the market, both of which are good feeds and desirable to buy if one has the opportunity. Rice bran is low in protein and differs

from wheat bran in this regard but is fairly digestible when of high grade and has about 1316 pounds of total digestible nutrients to the ton. It should be used in the place of corn meal, ground oats or ground barley instead of as wheat bran because of its low protein content. Rice polish could be used as one would use a fine flour middling but here again the rice polish would need more protein supplement than the wheat middlings.

Rice hulls are comparable to the buckwheat hulls, the analysis of which is given above only worse. In 2000 pounds of rice hulls are found only 284 pounds of total digestible nutrients. The hulls are unpalatable and should never be fed to animals. In buying rice bran one should see that there are no hulls in it. Here as in all cases, the analysis should be studied with care and the statement as to ingredients studied well to know that only rice bran is present and nothing else.

MISCELLANEOUS GRAINS—SORGHUMS AND MILLET

The sorghums are used for both forage and grain. They are of two general types the sweet or saccharine sorghums and the non-saccharine sorghum. The sweet sorghums are grown for forage and the non-saccharine types for both forage and grain. The principal use of sorghu mis as a substitute for corn in localities of insufficient rainfall to guarantee a crop of corn. It is probably not worth while in this article to spend much time on these as most of the readers of the WORLD will depend on corn. I think it is safe to say that there is no reason to try to grow any of the sorghums when corn will mature. Amber forage is a sweet sorghum.

There are three principal types of the grain sorghums, kafir with compact erect heads, durra heads compact and pendent and the broom corn type, heads loose and spreading. There are many varieties coming under each of these three types. "Milo maize" and "feterita" are of the durra type. "Shallu" and "kaoliang" are varieties in the broom corn group. All of these sorghums are grown more or less in the semi-arid parts of the United States, where it is too dry for corn and their value is proved by the great increase in acreage in the past few years.

The millets are rapid growing annual plants which may be used as hot weather catch crops. The most common type is the "foxtail millet" or "common millet". "Hungarian" millet and "German" are coarser larger yielding varieties which sacrifice in quality of forage and earliness what is

gained in quantity. Japanese millet, or "billion dollar grass" and "teosinte" are millets of little value. Where some millet is indicated as a forage catch crop probably the best results will be obtained by sticking to the "common" foxtail millet, sowing it thickly and cutting it early.

XXXI. The Oil Meals

Cottonseed, Linseed, Cocoanut and Soy Bean

THE oil meals most used for feeding at the present time are cottonseed oil meal, linseed oil meal, peanut oil meal and copra oil meal. In connection with these it is well to discuss some of the other by-products of these and closely allied industries. We will first take up cottonseed products.

In May, 1918, the value of the by-products from cottonseed of an annual cotton crop of 11,500,000 bales was given at $413,540,000. The oil from this cottonseed was valued at $246,340,000; the meal was valued at $111,238,000; the hulls and the linters would bring the remainder which amounts to $55,873,000. These prices serve to indicate what a tremendous business it is and also shows that the meal represents only about one-third of the total value of the cottonseed.

In the preparation of cottonseed meal the first step is to treat the seeds. The clean seeds then go to linter machines and here most of the cotton which still clings to the seeds is removed. The seeds are next hulled by passing them through revolving disks in which knives are set and the seeds are separated into the hulls and meats. The hulls are sold as such by most oil mills, but may later be mixed with the cottonseed meal for feeding.

The meats or kernels are next treated to extract the oil. The main process used in this is to cook the kernels with live steam and then the oil is pressed out, the seeds being kept hot during the pressing process.

After the cottonseed cake comes out of the press it is either broken up or ground up into a fine meal which we recognize as cottonseed meal. This meal contains a certain proportion of hulls and varies with the mill as to the amount of hull mixed in with the meal, and it varies with the mill whether the hulls are mixed in with the kernels before pressing, and thus become a part of the cake, or whether the cake is pressed free from hulls and then the hulls added afterwards.

Whatever the process of manufacture, the resulting meal is graded into three grades. The first grade, choice cottonseed meal which is defined as follows: "Choice cottonseed meal must be finely ground, not necessarily bolted, perfectly sound and sweet in odor, yellow, free from excess lint and must contain at least 41 per cent. protein."

The second quality of cottonseed meal contains more hulls than the first and consequently less protein. This second quality is called prime cottonseed meal and is defined as follows: "Prime cottonseed meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellow not brown or reddish, free from excess lint and must contain at least 38.6 per cent protein."

The third quality of meal is called good cottonseed meal and is defined officially as follows: "Good cottonseed meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color and must contain at least 36 per cent. protein."

Thus it will be seen that no by-product of the cottonseed industry can be called a meal and be sold as such unless it contains 36 per cent. protein. Any by-product of cottonseed sold for feeding purposes must be designated cottonseed feed if there is less than 36 per cent. protein in it.

In tentative definitions it has been proposed to change the name of the two lower grades of cottonseed meal to medium and lower grade cottonseed meal instead of prime and good cottonseed meal. There is a feeling that cottonseed meal containing only 36 per cent. protein and thus a large number of hulls should not be called good cottonseed meal.

To show the amount of hulls which may be incorporated into these three grades of meal the following result of analysis is given. A choice cottonseed meal containing at least 41 per cent. protein may contain 9.2 per cent. hulls by weight. Prime cottonseed meal running between 38.6 per cent. and 41 per cent. protein may contain 13 per cent. hulls. Good or low grade cottonseed meal may contain as high as 27 per cent. hulls and still have 36 per cent. protein in it. Therefore, it will be seen that when a farmer buys good cottonseed meal, so called, he may be buying as high as 27 per cent. hulls, or one-fourth of his meal may be hulls. Cottonseed hulls are about the poorest material that we can think of for feeding our animals. Since there are so many hulls to be gotten rid of, the amount of cottonseed meal on the market the past year has been almost entirely of the 36 per cent

variety. Cottonseed meal may contain as high as 50 per cent. protein.

When one sees that a good cottonseed meal containing 36 per cent. protein may contain as high as 27 per cent. hulls one easily realizes what a cottonseed feed is made of which is usually guaranteed to contain 20 per cent. protein. Such cottonseed feeds may contain as high as 80 per cent. hulls. The ground hulls have so much the appearance of the meal that it is impossible for one who is not expert to recognize the difference between a good cottonseed meal and a cottonseed feed containing only 20 per cent. protein. I do not believe that cottonseed feed is ordinarily sold as cottonseed meal, but I do believe that the higher grade meals are the less expensive meals to buy.

In order to get a comparison of feeding values it may be said that an average sample of choice cottonseed meal will have in it about 1564 pounds of total digestible nutrients, prime cottonseed meal 1510 pounds of total digestible nutrients and good cottonseed meal 1496 pounds of total digestible nutrients to the ton. Therefore, the 36 per cent. meal is only about seven-eighths the value of the choice cottonseed meal. Cottonseed feed containing 20 per cent. protein has in it only 1154 pounds of total digestible nutrients to the ton which makes it little better than good hay for feeding.

THE MANURIAL VALUE OF COTTONSEED MEAL

To illustrate the value of the high protein feeds as sources of fertilizing materials to our farms, we will call attention to the value of choice cottonseed meal. If a farmer should buy a ton of choice cottonseed meal and spread it on his land he would be putting on his land the equivalent of 171.4 pounds of ammonia, 53.4 pounds of phosphoric acid and 36.2 pounds potash. At the current values of fertilizing ingredients one ton of cottonseed meal used as a fertilizer would have a value comparable to commercial fertilizers of similar nature.

Suppose that instead of spreading this cottonseed meal directly on the land we feed it to cows. According to E. O. Fippin's estimates, Cornell University bulletin 127, entitled "Farm Manure", it is estimated that the cow would return in her manure 30 per cent. of the ammonia, 50 per cent. of the phosphoric acid and 40 per cent. of the potash. Therefore, after it has served its usefulness as a feed the resulting manure would have a fertilizing value equivalent to 51.4 pounds of ammonia, 26.7 pounds of phosphoric acid and 14.5 pounds

of potash as purchased in commercial fertilizers. Therefore, when a man purchases a high protein feed, such as cottonseed meal or oil meal, he can make a substantial reduction from the first cost price of the manurial value of these high protein feeds when the manure and urine are properly conserved.

FEEDING COTTONSEED MEAL

Cottonseed meal is a valuable source of protein and about the cheapest source of protein that we have during most years. This feed is particularly valuable for feeding dairy cattle, because when used in reasonable quantities in the mixture no harm seems to come from it. I usually advise that the cottonseed meal in a given mixture of concentrates for dairy cows should not exceed 40 per cent. of the mixture by weight. If gluten feed is being fed in the same mixture, I would not have the gluten and the cottonseed together exceed 40 per cent. of the mixture of concentrates by weight. There is a feeling that cottonseed meal feeding has a bad influence on the udder and that animals fed highly on cottonseed meal are predisposed to garget and other udder troubles. Also there is a feeling that high protein feeding, particularly of cottonseed meal will produce a harsh feeling hide, poor handling qualities and rough stary coat. However, admitting all of these criticisms to be more or less true, I still feel that we must make a large use of cottonseed meal in our dairy cow rations.

I would not feed cottonseed meal to horses, to hogs or to cattle under one year old. It is of great value as a protein supplement in rations for beef cattle. The general effect of cottonseed meal in feeds is constipating, and cottonseed meal is not advised if linseed meal is as cheap when there is no silage in the ration.

LINSEED OIL MEAL

One of the most useful feeds to the American farmer is oil meal from flax. Flax itself is too valuable for the oil it contains to be used as such for feeding although a small amount of ground flax seed is sometimes fed to calves.

In the manufacture of oil the flaxseed is ground, warmed up and the linseed oil pressed out leaving the cake behind. Most farmers like their oil meal ground up. European farmers who import much oil meal like it best in the form of the slabs just as they come from the press and break up these slabs in their own way. This is a sure way of not getting adulterated meal. This oil cake broken up into nut or pea

size is very palatable and in this size is preferred by lamb feeders to use as a supplement to corn.

At one time the linseed oil was extracted from the flax seed by another process, the oil being dissolved out with naphtha. The residue from this process was called new process oil meal. Only occasionally is such a meal encountered now. The new process oil meal contained less fat and was not as palatable.

The healthful qualities of old process oil meal add to its value. It is one of the finest high protein feeds we have and in addition it is laxative and stimulating to appetite and milk flow. There are 1558 pounds of total digestible nutrients to the ton in oil meal which shows its high value as a feed compared with all other feeds. Oil meal contains about 33 per cent. total protein of which 30 per cent. is digestible. On account of its valuable properties I should consider oil meal in a mixture of concentrates fully as valuable pound for pound as choice cottonseed meal or gluten feed. It makes a fine combination with these feeds. The manurial value of linseed oil meal would be somewhat less than that of the higher grade cottonseed meals because of a less protein content.

Linseed oil meal can be fed in any quantity to any animal provided that animal does not scour. Oil meal is laxative, and therefore, the amount that can be fed is limited. This feed is very useful in mixtures used for fitting cows for test. Here as high as 25 per cent. is often used in the mixture. In rations for milking cows or in production rations 20 to 30 per cent. can be used very well. It is a particularly fine feed for all growing animals and is fine for young calves with oats, bran and hominy. This feed is so good as a conditioner that it is often used as the base of so-called stock feeds and condition powders where a very high price is paid for it under a fancy name. Well animals, with a little oil meal with other good foods in their ration, do not need any stock feeds or condition powders and it is a waste of money to buy them.

OTHER FLAX PLANT BY-PRODUCTS

Flax feed consists of flax screenings and is not generally found on the market except as a component of mixed feeds.

Flax plant by-product contains some of the stem, some of the pods and some of the broken or immature flax seeds. It has little if any feeding value and should be avoided as such or as a component of mixed feeds. Sometimes the oil may be extracted from the unscreened flax seed giving us

what has been called "laxo" meal. Its value would of course be less than that of oil meal on account of screenings present.

PEANUT BY-PRODUCTS

Peanut oil is being used more than ever. It is another indication of the world shortage of fats. The extraction of oil from peanuts gives us two by-products, peanut oil meal and peanut feed. The difference is whether the peanut shucks are in or not. In the peanut oil meal the peanuts have been shelled before pressing. Peanut oil meal is a very high protein feed containing as high as 47 per cent. total protein. It is a highly digestible desirable feed, palatable to practically all animals.

The peanut feed is made from the unhulled nuts and the shucks reduce the protein to about 23 per cent. and raises the fiber to about 27 per cent. The peanut shucks are very poor feed and practically worthless. Therefore, one should be very careful of the price in buying this feed. Peanut shucks are sometimes used as an adulterant but feeding stuffs laws are gradually eliminating this sort of thing.

COCOANUT OIL MEAL

The demand for vegetable fats for nut butters and other uses has very greatly increased the production of cocoanut oil. Cocoanut oil is derived from the dried cocoanut meats. These dried cocoanut meats are produced in large quantities in the Philippines and other Pacific islands. The commercial name for dried cocoanut meats is copra. This has given rise to another name, copra oil meal which is synonymous with cocoanut oil meal.

Cocoanut oil meal is a clean, fine, finely ground meal of pleasant odor and taste which is palatable to dairy cows. It is probably a little less valuable pound for pound than gluten feed and can be used very much like gluten feed. Cocoanut oil meal contains about 20 to 23 per cent. total protein of which 18.8 per cent. is digestible. There are about 1580 pounds of total digestible nutrients in a ton. You will remember that the total digestible nutrients in a ton of gluten feed is 1612. One of the things which has been urged against cocoanut oil meal as a feed has been the fact that it will not keep in storage. I have kept in storage in southern New York nine tons of cocoanut oil meal for eighteen months in an ordinary storage shed that was dry and hot. During the summer the cocoanut oil meal did not get at all rancid but it did become somewhat lumpy. However,

it was not much trouble in crushing the lumps with a shovel. This is a new feed which is likely to increase in quantity and farmers should make themselves familiar with it so that it can be purchased whenever there is a price advantage.

SOYBEAN MEAL

A little soybean oil meal comes on the market occasionally. It is the by-product of the manufacture of oil from soybeans. The by-product when available is one of the very highest of the desirable high protein feeds. It will run about 40 per cent. protein of which 38 per cent. is digestible and there is about 1660 pounds of total digestible nutrients in a ton. Soybean oil meal is supposed to have an extra value on account of the vitamines contained in it. It is doubtful, however, for general feeding whether it would be worth any more than choice cottonseed meal.

Other oil meals of somewhat the same value would be the palm nut oil meal and oil meal from sunflower seeds. These, however, are of so small a quantity on the market that it is not worth while to go much into discussion. When available they would be used in much the same way and have much the same value of the oil meals that have already been described.

VELVET BEAN MEAL AND FEED

The acreage of velvet beans grown in the South is gaining and more and more we are having velvet bean meal and velvet bean feed available for feeding dairy cattle. The oil is not extracted from velvet beans so that velvet bean meal is the whole ground bean. The amount of fat in velvet beans is not high so it is not likely that velvet beans will ever be used as a source of oil. Velvet bean meal should be a very good feed of about 20 per cent. total protein with about 1600 pounds of total digestible nutrients to the ton. Velvet bean feed is made by grinding the beans, pod and all together after they have been thoroughly dried. Of course the pod is not so valuable as the bean and this gives us a product with less protein, having only about 17 per cent. with more fiber. The pod is not so digestible as the seeds, consequently the amount of digestible nutrients is lowered to something less than 1500. This makes velvet bean feed about the same value and usefulness as wheat feed.

This finishes the description of the oil meals and one or two of the meals derived from some of the legume seeds. This whole class of feeds makes up one of the most valuable of our sources of feeds for feeding dairy cattle.

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